

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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HUM INDUSTRIAL TECHNOLOGY, INC.  
*Petitioner*

v.

AMSTED RAIL COMPANY, INC.  
*Patent Owner*

Patent No. 9,981,673  
Issue Date: May 29, 2018  
Title: SYSTEM AND METHOD FOR MONITORING  
RAILCAR PERFORMANCE

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*Inter Partes* Review No. IPR2023-00539

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**DECLARATION OF STEVEN RICCA  
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW  
OF U.S. PATENT NO. 9,981,673**

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## **I. INTRODUCTION**

1. I, Steven Ricca, offer this declaration in support of the Petition for Inter Partes Review of U.S. Patent No. 9,981,673 (“the ’673 patent”). I am over the age of 18, competent to make this declaration, and have personal knowledge of the facts set forth below. If called to testify, I could and would testify honestly, under oath, to the matters set forth herein.

2. I am not an attorney, and I have not been asked to offer any legal opinions. I have been informed and understand the law to be applied for determining invalidity, which I explain in places below. I have applied the law told to me in developing my technical opinions in this Declaration.

## **II. BACKGROUND AND QUALIFICATIONS**

### **A. Education and Work Experience**

3. I have over 30 years of experience in electrical and systems engineering, including in the railroad industry specifically. I have direct experience within a variety of private companies and industries. I earned my B.S. and M.S. in Electrical Engineering from Ohio University in 1986 and 1988, respectively. My curriculum vitae attached to this declaration as Exhibit 1004 contains a detailed description of my work history and education.

4. At Toledo Scale (1988-1990) I was the lead firmware engineer for a new scale for railcars. Much of the work I did at Toledo Scale led to applications that were industry firsts. For example, I developed electronic systems and software

that measured weight. This included railcar weight, and within that sector some of the first in-motion weighers and automated tank car fillers. Often the wayside communication systems were located near the weighing equipment due to electrical runs, so understanding the wayside communication systems in combination with the weighing equipment was critical.

5. At IRD Mechanalysis (1990-1995) I developed systems that measured all parameters of rotating machinery. This included all types of sensors within systems that monitored and analyzed data in real-time with authority to shut down or signal the system for a shutdown. Very complex systems involving hundreds of accelerometers, temperature sensors and other position detectors were typical. These systems often performed complex algorithms and comparisons on the data for shutdown analysis; as well as storing the compressed data for offloading to larger storage locations using a variety of communications methods. This company pioneered many of the concepts of predictive/preventive maintenance and communicating the system health to outside entities for scheduled service and maximum uptime.

6. At Dynalab, where I was senior electronic engineer from June 1997 to July 2002, I developed several test instruments used by the transportation and appliance industries to test cable and harness assemblies prior to final assembly in to the vehicle or appliance. This work included designing and developing

microprocessor based relay boards, a DC-DC power supply, and understanding the upcoming trends in transportation wiring. The cable analyzer testing equipment was programmable to check for the continuity of connections, splices and the presence of fuses and surge suppression devices. They also could analyze the signal path for high speed communication line.

7.           A few jobs and several years later, I worked at Invensys (2004-2006) as a Senior Electrical Engineer. I was responsible for overseeing the automotive climate controls products division. One of my responsibilities was to design a high-volume microcontroller based automotive product family to replace the existing laser trimmed controls which had become difficult to manufacture. Also, our engineering group developed controls for the HVAC industry which would measure and communicate system health to outside entities for preventive maintenance programs. We also developed thermostats and smoke alarms using mesh networking.

8.           Since my job at Invensys in 2006, I have continued to work in the electrical and systems engineering industry, leading up to my current job as Lead Electrical Engineer with Vertiv Holdings. My responsibilities include electrical coordination and oversight of multiple product development programs carried out in four design centers worldwide. I also have my own consulting/product development company, Ricca Engineering, LLC, that I have operated since around

2002. Some of my projects have included embedded firmware, analog and digital hardware design, building prototypes, schematic circuit design, simulation and PCB layout, and motorized controls for museum exhibits among others.

9. I have held numerous other positions in my 30-plus years in the engineering field, as shown on my curriculum vitae. Not all have been discussed in detail in my declaration.

10. I have prepared numerous written documents over my career in the engineering field, including operating manuals, technical specifications, and internal research and development documents. With few exceptions, these documents have been kept confidential by the companies that own them, and have not been publicly disclosed or otherwise made available to competitors. For this reason, none of these documents are listed on my curriculum vitae (EX1004).

11. My background demonstrates an expertise and strong understanding of railroad monitoring systems, as well as communications networks used in these systems, such as mesh networks.

## **B. Engagement**

12. I have been retained as an independent expert consultant by Hum Industrial Technology, Inc. (“Petitioner”) in connection with a petition for *inter partes* review of U.S. Patent No. 9,981,673 (the “’673 Patent,” EX1001).

13. Specifically, I was asked to investigate and opine on the technology claimed in, and the patentability or unpatentability of certain claims of the '673 Patent. Specifically, I was asked to opine on the validity of claims 1–18 and 20–22 (the “Challenged Claims”) of the '673 Patent.

14. Although I am being compensated for my services in this matter at my standard consulting rate of \$375 per hour, my compensation is not contingent upon the opinions I render or the outcome of this proceeding. I have no financial interest in any of the parties, and I have no other interest in this proceeding.

15. This report is based on information currently available to me. I reserve the right to amend or supplement my analysis in this report and/or to respond to any additional submissions prepared by or on behalf of the Patent Owner. I also reserve the right to amend or supplement my opinions based on further discovery and information provided in the case.

16. I reserve the right to create any additional summaries, tutorials, demonstrations, charts, drawings, tables, and/or animations that may be appropriate to supplement and demonstrate my opinions as necessary.

17. All of the opinions stated in this report are based on my own personal knowledge and professional judgment.

### **III. MATERIALS CONSIDERED**

18. I have considered the following list of materials in formulating my opinions in this matter:

| <b>Ex #</b> | <b>Exhibit Description</b>                                                                                                        |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1001        | U.S. Patent No. 9,981,673 (“the ’673 patent”)                                                                                     |
| 1002        | Prosecution History of the ’673 Patent                                                                                            |
| 1005        | U.S. Patent Publication No. 2007/0152107 A1 to LeFebvre et al. (“LeFebvre”)                                                       |
| 1006        | U.S. Patent Publication No. 2011/0282540 A1 to Armitage et al. (“Armitage”)                                                       |
| 1007        | U.S. Patent Publication No. 2007/0208841 A1 to Barone et al. (“Barone”)                                                           |
| 1008        | U.S. Patent Application Publication No. 2008/0195265 to Searle et al. (“Searle”)                                                  |
| 1009        | U.S. Patent No. 6,339,397 to Baker et al. (“Baker”)                                                                               |
| 1010        | U.S. Patent No. 6,487,478 to Azzaro et al. (“Azzaro”)                                                                             |
| 1011        | Amsted Rail Company, Inc.’s Complaint filed against Hum Industrial Technology, Inc. (ECF No. 1) filed on April 18, 2022           |
| 1012        | Waiver of the Service of Summons upon Hum Industrial Technology, Inc. (ECF No. 4) dated June 14, 2022                             |
| 1013        | U.S. Provisional Application No. 61/661,661 (“the ’661 Provisional”)                                                              |
| 1014        | U.S. Patent Application No. 12/861,713 (“the ’713 Application”)                                                                   |
| 1015        | U.S. Patent No. U.S. 7,688,218 to LeFebvre et al. (“LeFebvre ’218”)                                                               |
| 1016        | Third Generation On-Board Monitoring and Control System Based on Controller Area Network Technology Dr. John Donelson III, et al. |
| 1017        | Defendants' Stipulation of Invalidity Contentions                                                                                 |
| 1018        | U.S. Patent Application Publication No. 2005/0194497 to Matzan (“Matzan”)                                                         |

#### **IV. OVERVIEW OF THE PATENT AT ISSUE**

19. I have read and considered the '673 patent, filed on May 18, 2016, as well as its prosecution history. (EX1002).

20. It is my understanding that the '673 Patent relates, broadly speaking, to a system for wirelessly monitoring the operating parameters and/or conditions of a railcar. EX1001, (57) Abstract. The system includes one or more sensor units that communicate wirelessly with a "communication management unit," or "CMU," mounted on the railcar. *Id.* The system can determine whether an alarm condition is present based upon data collected from the sensor units. *Id.*

21. I understand that the '673 Patent issued on May 29, 2018 from an application filed on May 18, 2016. The '673 Patent is a continuation of U.S. Patent Application No. 13/842,427 ("the '427 Application"), which issued as U.S. Patent No. 9,365,223. The '673 Patent also claims priority to U.S. Provisional Application No. 61/661,661, filed on June 19, 2012. (EX1013). I also understand that the '673 Patent claims to be a continuation-in-part of U.S. Patent Application No. 12/861,713, filed on August 23, 2010. (EX1014).

22. For the purposes of preparing my opinion, I have been informed that the Challenged Claims are entitled to a priority date of no earlier than June 19, 2012. Specifically, I have been informed that each independent claim of the '673

Patent recites at least one limitation that was newly added in the '427 Application, and is neither disclosed in nor supported by the '713 Application.

| <b>Independent Claim</b> | <b>Exemplary Limitation(s) Without Support in the '713 Application</b>                       |
|--------------------------|----------------------------------------------------------------------------------------------|
| 1                        | “applying a heuristic”; “assigning a severity level”                                         |
| 10                       | “sensing the temperature”; “a temperature sensor”                                            |
| 14                       | “heuristically analyzing said received data”; “a statistical analysis of said received data” |
| 21                       | “analyzing said collected data by applying heuristics thereto”                               |

23. However, even if the Challenged Claims were entitled to a priority date of August 23, 2010, it is my opinion that the claims would still be unpatentable over the prior art as it existed prior to August 23, 2010. *See* Sections IX.C and IX.D below.

**A. Prosecution History of the '673 Patent**

24. During prosecution of the '673 Patent, I understand that the first Office Action, issued June 29, 2017, rejected all pending claims over US 2008/0195265 (“Searle”) in view of US 6,339,397 (“Baker”). EX1002, 106-121. In a response filed October 13, 2017 (EX1002, 419-434), Amsted argued that Searle and Baker:

- 1) Failed to disclose “*assigning a severity level* to said deviations from nominal operating conditions” (EX1002, 425);

- 2) Failed to disclose “sensing the temperature of a part of the railcar *other than the desired part* by use of a temperature sensor in thermal communication with said other part” (EX1002, 428); and
- 3) Failed to disclose heuristically analyzing sensor data “to determine if an actual failure exists” *or* “to predict potential or imminent failures.” (EX1002, 431.)
25. This argument resulted in a Notice of Allowability. EX1002, 48-495.
26. I understand that the Office did not rely upon LeFebvre, Armitage, or Barone to reject any claims during prosecution of the ’673 Patent.
27. As I will explain in detail below, it is my opinion that LeFebvre, Armitage, and Barone disclose the methods claimed by the ’673 Patent and render the challenged claims obvious under 35 U.S.C. § 103.

## **B. Listing of Claims**

28. The issued claims of the ’673 Patent are listed in the table below. To provide consistency with the Petition, I have adopted the same shorthand numbering for the claims, and individual claim limitations, of the ’673 Patent. For example, as indicated in the table below, I may use “Limitation 1(b)” as a shorthand reference to the limitation “applying a heuristic to said received data to determine deviations from nominal operating conditions” in claim 1.

| <b>Claim Designation</b> | <b>Claim Language</b>                                                                                                                                                                                             |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Claim 1 Preamble         | A method of monitoring operational characteristics of a railcar comprising the steps of:                                                                                                                          |
| Limitation 1(a)          | a. receiving data or processed information regarding said operational characteristic from one or more sensing units on said railcar, said sensing units monitoring an operational characteristic of said railcar; |
| Limitation 1(b)          | b. applying a heuristic to said received data to determine deviations from nominal operating conditions;                                                                                                          |
| Limitation 1(c)          | c. assigning a severity level to said deviations from nominal operating conditions; and                                                                                                                           |
| Limitation 1(d)          | d. determining an alarm condition based on said assigned severity level.                                                                                                                                          |
|                          |                                                                                                                                                                                                                   |
| Claim 2                  | The method of claim 1 further comprising the initial step of establishing wireless communication with said one or more remote sensing units.                                                                      |
|                          |                                                                                                                                                                                                                   |
| Claim 3                  | The method of claim 2 wherein said one or more remote sensing units form a mesh network.                                                                                                                          |
|                          |                                                                                                                                                                                                                   |
| Claim 4                  | The method of claim 2 wherein steps a-d are executed by a processing unit located on said railcar.                                                                                                                |
|                          |                                                                                                                                                                                                                   |
| Claim 5                  | The method of claim 4 wherein said processing unit located on said railcar is a part of said mesh network.                                                                                                        |
|                          |                                                                                                                                                                                                                   |
| Claim 6                  | The method of claim 2 further comprising the step of transmitting said alarm condition to a location remote from said railcar.                                                                                    |
|                          |                                                                                                                                                                                                                   |
| Claim 7                  | The method of claim 2 further comprising the step of transmitting said data received from said one or more sensing units to a location remote from said railcar.                                                  |
|                          |                                                                                                                                                                                                                   |

|                   |                                                                                                                                                                      |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Limitation 8(a)   | The method of claim 2 further comprising the steps of:<br>receiving data from a plurality of railcars;                                                               |
| Limitation 8(b)   | applying a heuristic to said received data to determine<br>deviations from nominal operating conditions;                                                             |
| Limitation 8(c)   | assigning a severity level to said deviations from nominal<br>operating conditions;                                                                                  |
| Limitation 8(d)   | determining an alarm condition based on said assigned<br>severity level;                                                                                             |
| Limitation 8(e)   | transmitting said raised alarm to a display unit on a train of<br>which said plurality of railcars are a part.                                                       |
|                   |                                                                                                                                                                      |
| Limitation 9(a)   | The method of claim 6 further comprising the steps of<br><br>a. determining a recommended course of action based on<br>said alarm condition; and                     |
| Limitation 9(b)   | b. transmitting said recommended course of action to a<br>display unit on a train of which said railcar is a part.                                                   |
|                   |                                                                                                                                                                      |
| Claim 10 Preamble | A method of monitoring a temperature of a desired part of a<br>railcar, comprising:                                                                                  |
| Limitation 10(a)  | (a) sensing the temperature of a part of the railcar other than<br>the desired part by use of a temperature sensor in thermal<br>communication with said other part; |
| Limitation 10(b)  | (b) determining the temperature of the desired part by use of<br>the temperature sensed in step (a);                                                                 |
| Limitation 10(c)  | (c) determining if said temperature of the desired part is<br>outside an acceptable range of temperatures; and                                                       |
| Limitation 10(d)  | (d) transmitting an alarm if in step (c) it is determined that<br>the temperature of the desired part is outside an acceptable<br>range.                             |
|                   |                                                                                                                                                                      |

|                   |                                                                                                                                                                                                                                                                                             |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Claim 11          | A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, further comprising the step of determining the temperature of the ambient air, which temperature is used in the determination of step (b).                                                 |
| Claim 12          | A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, wherein steps (a) through (d) are carried out by a single unit attached to said railcar.                                                                                                   |
| Claim 13          | The method of claim 1 wherein steps (a) through (d) can be carried out at different event engines distributed among at least two of said sensor units, a communication management unit, and a mobile or land base station.                                                                  |
| Claim 14 Preamble | A method for monitoring the operation of a railcar performed by a communication management unit disposed on said railcar comprising the steps of:                                                                                                                                           |
| Limitation 14(a)  | a. wirelessly receiving data from one or more sensing units which periodically collect readings from one or more sensors disposed on said railcar;                                                                                                                                          |
| Limitation 14(b)  | b. heuristically analyzing said received data to determine if an actual failure exists on said railcar or to predict potential or imminent failures based on a statistical analysis of said received data; and                                                                              |
| Limitation 14(c)  | c. communicating the results of said analysis to an off-railcar location.                                                                                                                                                                                                                   |
| Limitation 15(a)  | The method of claim 14 wherein each of said sensing units can make a determination of an alarm condition based on data collected by the sensing unit, said method further comprising the step of:<br><br>a. wirelessly receiving notice of said alarm condition from said sensing unit; and |
| Limitation 15(b)  | b. communicating said alarm condition to an off-railcar location.                                                                                                                                                                                                                           |

|                   |                                                                                                                                                                                                                         |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   |                                                                                                                                                                                                                         |
| Limitation 16(a)  | The method of claim 14 further comprising the steps of:<br><br>a. making a determination of an alarm condition based on data received from two or more of said sensing units; and                                       |
| Limitation 16(b)  | b. communicating said alarm condition to an off-railcar location.                                                                                                                                                       |
|                   |                                                                                                                                                                                                                         |
| Claim 17          | The method of claim 14 further comprising the step of placing said one or more sensing units in a stand-by state when said one or more sensing units is not reading data from any of said sensors or transmitting data. |
|                   |                                                                                                                                                                                                                         |
| Claim 18          | The method of claim 14 further comprising the step of joining a mesh network consisting of one or more sensing units located on said railcar.                                                                           |
|                   |                                                                                                                                                                                                                         |
| Limitation 20(a)  | The system of claim 14 further comprising the steps of:<br><br>a. saving data received from said one or more sensing units in memory; and                                                                               |
| Limitation 20(b)  | b. comparing data received with said saved data to identify trends or deviations from normal readings of said data stored in memory.                                                                                    |
|                   |                                                                                                                                                                                                                         |
| Claim 21 Preamble | A method for monitoring the operation of a railcar comprising:                                                                                                                                                          |
| Limitation 21(a)  | a. collecting data at periodic intervals about one or more operating parameters of said railcar using one or more sensor units provided on said railcar;                                                                |
| Limitation 21(b)  | b. communicating said collected data to a communication management unit;                                                                                                                                                |
| Limitation 21(c)  | c. analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data. |

|                  |                                                                                                                                        |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Limitation 22(a) | The method of claim 21 further comprising the steps of:<br><br>assessing the collected data to determine if an alarm condition exists; |
| Limitation 22(b) | and wirelessly communicating said alarm condition to an off railcar location.                                                          |

## V. STATE OF THE ART

29. It is my opinion that Amsted did not invent railcar monitoring systems, or methods of operating such systems as claimed in the '673 Patent. In fact, railcar monitoring systems using sensors to detect operational anomalies using heuristics (including statistical analysis) were well-known in the art at the time the '673 Patent was filed. *See generally* EX1005 (LeFebvre), EX1006 (Armitage), EX1007 (Barone). The '673 Patent claims simply recite well-known processes and components (including but not limited to sensors, communication management units, mesh networks, and event processing engines) to yield predictable results that have been employed for decades. *See generally* EX1005 (LeFebvre), EX1006 (Armitage), EX1007 (Barone). There is nothing novel about collecting data through sensors located on a railcar, analyzing the data, and sending messages through a communication architecture (for example, through a mesh network) to detect operational anomalies and inform the railcar operator of operational conditions of a railcar.

30. As far back as 1999, the Federal Railroad Administration's Office of Research and Development (FRA) sponsored the development of onboard monitoring systems for trains. EX1016, p. 1. In June 1999, the multi-year project commenced, with prototypes being tested as early as November 2000. EX1016, pp. 1-2. In 2003, an onboard monitoring system was developed that used the latest wireless communications and bearing monitoring technology. EX1016, p. 2. By the time Donelson was published (2007), a monitoring system called the "On-Board Monitoring and Control System" ("OBMCS") was under development. EX1016, p. 2. The OBMCS contained a modular architecture with a network of microcontrollers linked by a Controller Area Network ("CAN") bus. EX1016, p. 2.

31. The OBMCS architecture considered cost and power consumption in its development. EX1016, p. 2. The OBMCS contained sensors to monitor mechanical operations, which were mounted on railcars and linked together via a wireless network (WLAN) to a computer in the locomotive. EX1016, p. 3. The computer in the locomotive displayed system status information and transmitted messages to actuators on the cars, which controlled and operated mechanical systems. EX1016, p. 3. Figure 1 of Donelson shows the architecture generally.

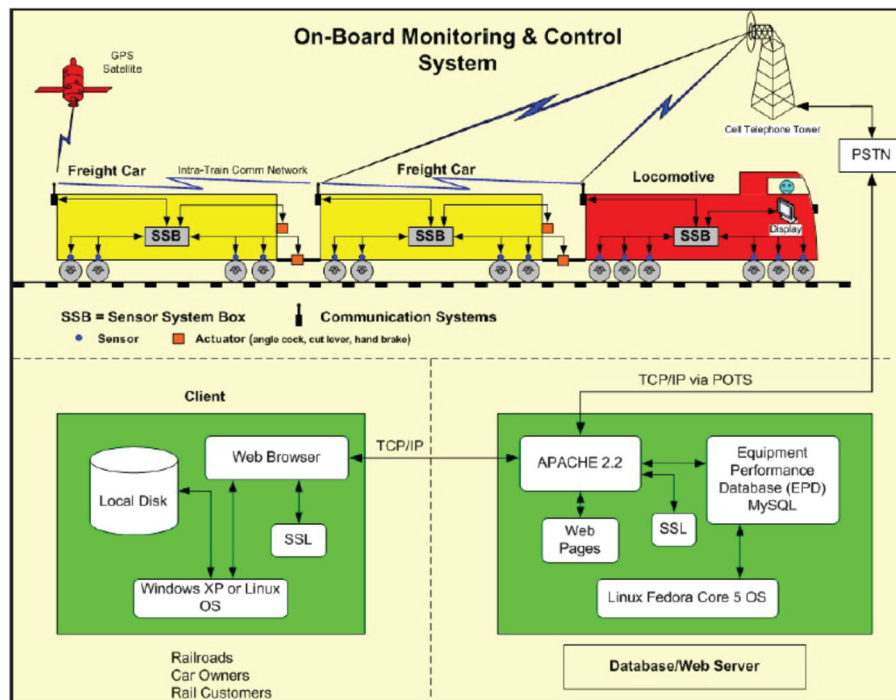


**Figure 1: Top-level OBMCS architecture**

32. OBMCS can use a number of wireless communications technologies, including Global System for Mobile communications (“GSM”), or a Code Division Multiple Access (“CDMA”) cell phone with 1X Radio Transmission Technology (“1XRTT”) in order to establish a two-way internet connection between the train and database server. EX1016, p. 3. Figure 2 of Donelson shows a diagram of sensors, communications systems, and power subsystem components installed on the railcars. It also includes a list of mechanical systems that can be monitored remotely from the locomotive, including accelerometers. EX1016, pp. 3-4. These accelerometers generate data which is then analyzed with a digital signal processing algorithm. EX1016, p. 8.

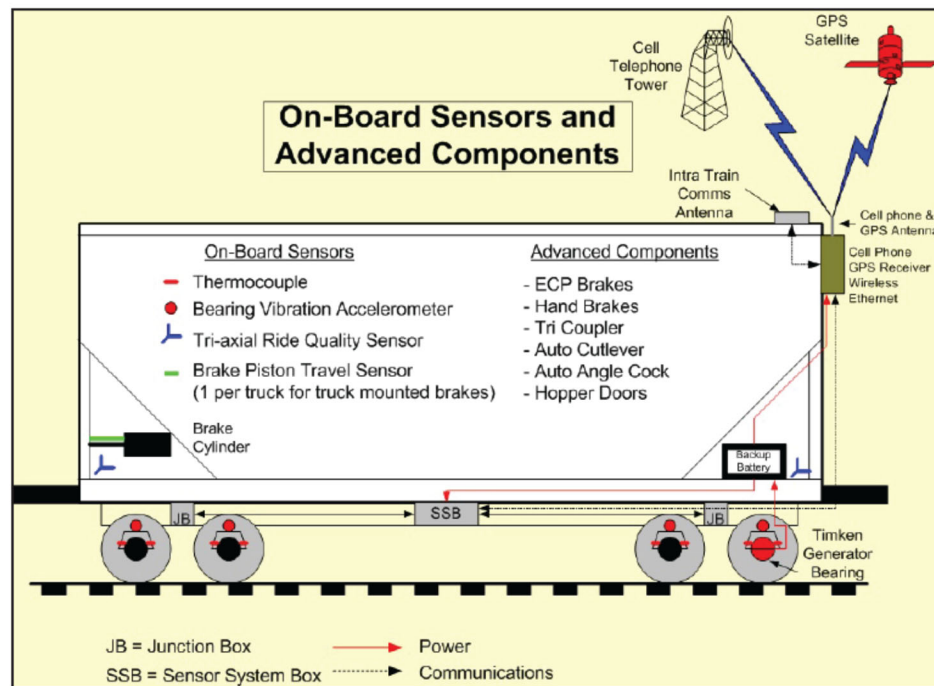


**Figure 2: OBMCS sensors, actuators, and communication systems**

33. OBMCS includes accelerometers for purposes of continuously monitoring derailment and intermittently monitoring bearing and wheel defects. EX1016, p. 4. It also includes tri-axial accelerometers for monitoring ride quality – including laterally, vertically, and longitudinally oriented sensors for detecting hunting, pitching, bouncing, and shock events. EX1016, p. 4.
34. OBMCS includes bearing temperature sensors embedded inboard and outboard on bearing adapters to continuously measure bearing temperature. EX1016, p. 4. The temperature sensor data is sampled periodically (every 30

seconds), and analyzed to determine whether an alarm message should be sent to the locomotive. EX1016, p. 9.

35. OBMCS also has a Sensor System Box (“SSB”) which includes a single board embedded computer system that manages all communications between OBMCS and external systems (including the locomotive). EX1016, p. 4. The Accessory Interface Box (“AIB”) provides a standard physical connection scheme for interfacing sensors and actuators to the CAN bus. EX1016, p. 5.

36. Donelson discusses various communication systems for the OBMCS, including mesh networks. EX1016, p. 6. The system can also use GPS or cell phone telemetry. EX1016, p. 6. The locomotive computer in OBMCS utilizes software to exchange messages regarding the railcar status information and implement control functions. EX1016, p. 7.

37. OBMCS utilizes a number of algorithms and analog to digital circuitry in microcontrollers to analyze information in the form of sensor signals. EX1016, pp. 8-9. These signals are filtered using a low-pass filter and processed by algorithms and compared to other relational data to classify present situation and determine whether an alarm message needs to be sent. EX1016, p. 9.

38. The primary objective of the OBMCS disclosed in Donelson is to improve railroad safety and efficiency through new technologies and continuous monitoring to avoid breakdowns and accidents. EX1016, pp. 9-10. In 2007, on-

board power, communication networks, and advanced signal processing was available and well known. EX1016, p. 10. While cost, performance, and reliability were considerations for the OBMCS, none of these considerations rendered OBMCS impossible even as early as 2007 when Donelson was published. For example, the automotive industry had been successfully implementing cost effective packaging of complex electronics and computing/control power in automobiles for many years before this. It is my opinion that Donelson accurately depicts the state of the art in 2007 (or earlier), proving the technology claimed in the '673 Patent was already widely known and accepted in the field at least 5 years before its filing.

39. As a further example, a prior art reference relied on in the Petition, Barone, also provides a detailed background of the invention and state of the art at the time of Barone in 2007—5 years before the provisional application that led to the '673 Patent was filed. EX1007, (22), (65), (60). Barone lists a large number of publicly available articles and publications, dating as far back as the mid-1990's, that disclose onboarding monitoring systems similar to that described and claimed by the '673 Patent. EX1007, ¶¶ [0014]–[0020].

40. Barone notes that, because wayside detection systems turned out to be cheaper and easier to implement in the real world, onboard monitoring systems were not widely utilized in the industry. EX1007, ¶ [0021]. But this changed in the

mid-2000s, when the general progress of technology meant that electronic components—such as sensors, microprocessors, and wireless networking equipment—became cheap and widely available. By the time Barone was published in 2007, it recognized that “[o]nboard monitoring of fleets of railroad cars is more economically feasible due to the drastic decrease in the cost of modern sensors and electronics when mass produced.” EX1007, ¶ [0042].

41. Mesh networks first appeared in the 1980’s and have been well-known in the art since the 1990’s. Barone discloses a mesh network as part of the communication network of the system, showing mesh networks were utilized in onboard railcar monitoring systems at least as early as 2007. *See, e.g.*, EX1007, ¶ [0086]. Other prior art references relied on in the Petition further support the fact that mesh networks were utilized in railcar monitoring systems and were well-known in the art years before the filing date of the ’673 Patent. *See, e.g.*, LeFebvre, EX1005, ¶¶ [0031]–[0032].

## **VI. LEVEL OF ORDINARY SKILL IN THE ART**

### **A. Legal Principles**

42. I have been informed that patents are considered from the perspective of a person having ordinary skill in the art, and that this is a hypothetical person who is presumed to know the relevant prior art.

43. I have been informed that the following five factors inform the analysis for determining the level of ordinary skill in the art: (1) type of problems encountered in the art; (2) prior art solutions to those problems; (3) rapidity with which innovations are made; (4) sophistication of the technology; and (5) educational level of active workers in the field. I have also been informed that in a given case, every factor may not be present, and one or more factors may predominate. *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). I apply these factors in the section below in providing my opinion as to the level of one having ordinary skill in the art.

**B. Opinion as to the Level of a Person Having Ordinary Skill in the Art of the '673 Patent**

44. I have knowledge relevant to what a person having ordinary skill in the art at the time of the invention would understand and do. In 2012, at the priority date of the '673 patent, I had 24 years of experience in this field and was a person having ordinary skill in the art.

45. In my opinion, and applying the factors set forth above in paragraph 43 above, a person of ordinary skill in the art at the time of the filing of the '673 patent would be a person with at least a B.S. degree in electrical or mechanical engineering or a related field with at least two years' experience designing monitoring systems for railcar components, rotating equipment, or equivalent industrial equipment. It is my opinion that less work experience could be

compensated by a higher level of education, such as a master's degree, and vice versa.

## **VII. CLAIM CONSTRUCTION**

### **A. Legal Principles**

46. I have been informed that in a proceeding for *inter partes* review, claims terms in an unexpired patent are to be given their plain and ordinary meaning, as understood by a person having ordinary skill in the art, in view of the patents' specification. *See* 42 CFR § 42.100(b); 83 FR 51340; *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

### **B. Opinion of Claim Construction**

47. I believe that all claim terms, for the purposes of *inter partes* review can be given their plain and ordinary meaning.

48. The Board need not construe the claims and may give each and every term its plain and ordinary meaning because the claims are invalid under the plain and ordinary meaning.

## **VIII. SUMMARY OF THE PRIOR ART**

49. I have been informed that each of Armitage, Barone, and LeFebvre are prior art to the '673 Patent under the law.

### **A. LeFebvre**

50. LeFebvre is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1005, (57) Abstract.

LeFebvre's system utilizes a plurality of sensors to monitor the wheels and wheel bearings on each railcar, wherein the sensors communicate wirelessly with a control unit located on the railcar. *Id.* As I will explain in further detail below, LeFebvre's "control node" is a "communication management unit" in the parlance of the '673 Patent.

51. Data collected by the control unit is analyzed using heuristics to determine, for example, if a wheel bearing failure is approaching or imminent. EX1005, ¶¶ [0058]–[0059]. If a failure condition is detected, an alarm is wirelessly transmitted to a data processing system in a remote location. EX1005, ¶¶ [0038], [0052]. A PHOSITA would understand that the alarm is displayed to a human operator who can then take appropriate action.

## **B. Armitage**

52. Armitage discloses a "mobile railway car monitoring system [including] a plurality of sensor nodes coupled to an undercarriage portion of a railway car." EX1006, ¶ [0004]. Figure 1 of Armitage depicts an exemplary embodiment with four sensor nodes 121–124 attached to a railcar 110. EX1006, ¶ [0012], Fig. 1.

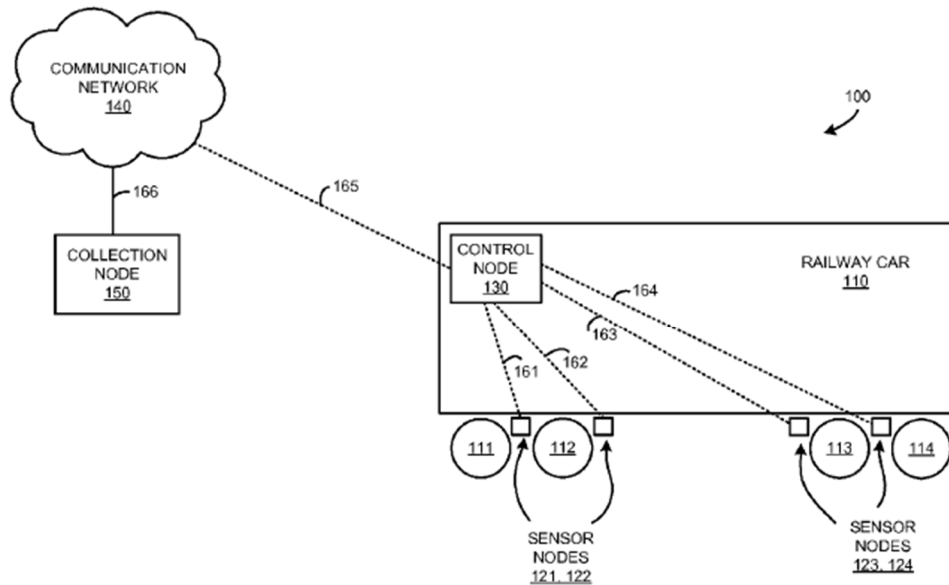


**FIGURE 1**

53. “Sensor nodes 121-124 each include equipment to sense and report information about undercarriage elements of a railway car.” EX1006, ¶ [0014]. Each sensor node “includes a sensor portion” that “could include thermometers” or “other sensing equipment and circuitry.” *Id.* The system also includes a “control node” on each railcar. EX1006, ¶¶ [0004], [0012], Figs. 1, 3, 5. The control node is a “communication management unit” in the parlance of the ’673 Patent.

54. Data collected by the control unit is analyzed using heuristics to determine, for example, if a component failure is approaching or imminent. EX1006, ¶ [0027]. If a failure condition is detected, an alarm is wirelessly transmitted to a collection node in a remote location. EX1006, ¶ [0028]. A PHOSITA would understand that the alarm is displayed to a human operator who can then take appropriate action.

### C. Barone

55. Barone is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1007, (57) Abstract. Barone's system utilizes a plurality of sensors to monitor the wheels and wheel bearings on each railcar, wherein the sensors are connected using a wireless mesh network, such as Zigbee. *Id.*

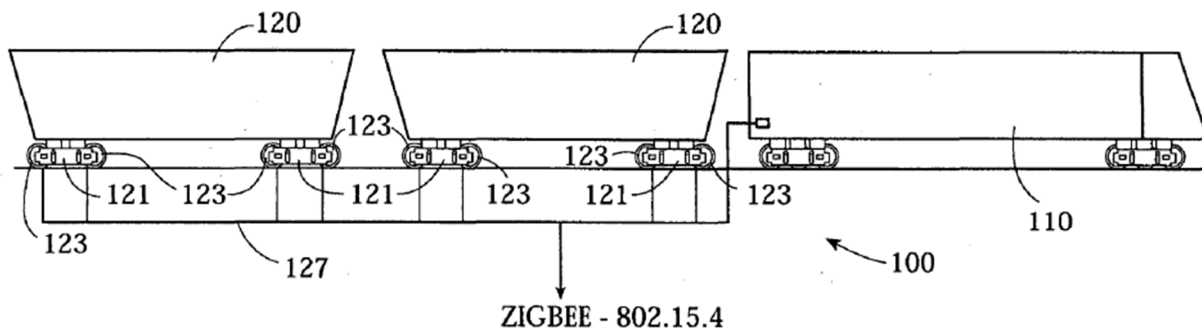


FIG. 1

56. The collected data is analyzed using heuristics to determine, for example, if a wheel bearing failure is approaching or imminent. EX1007, ¶¶ [0201]–[0220]. If a failure condition is detected, an alert (including the underlying data) is communicated to the locomotive and/or to a central monitoring station in a remote location. EX1007, ¶ [0045]. This is illustrated by Figure 2 of Barone, which I have reproduced below.

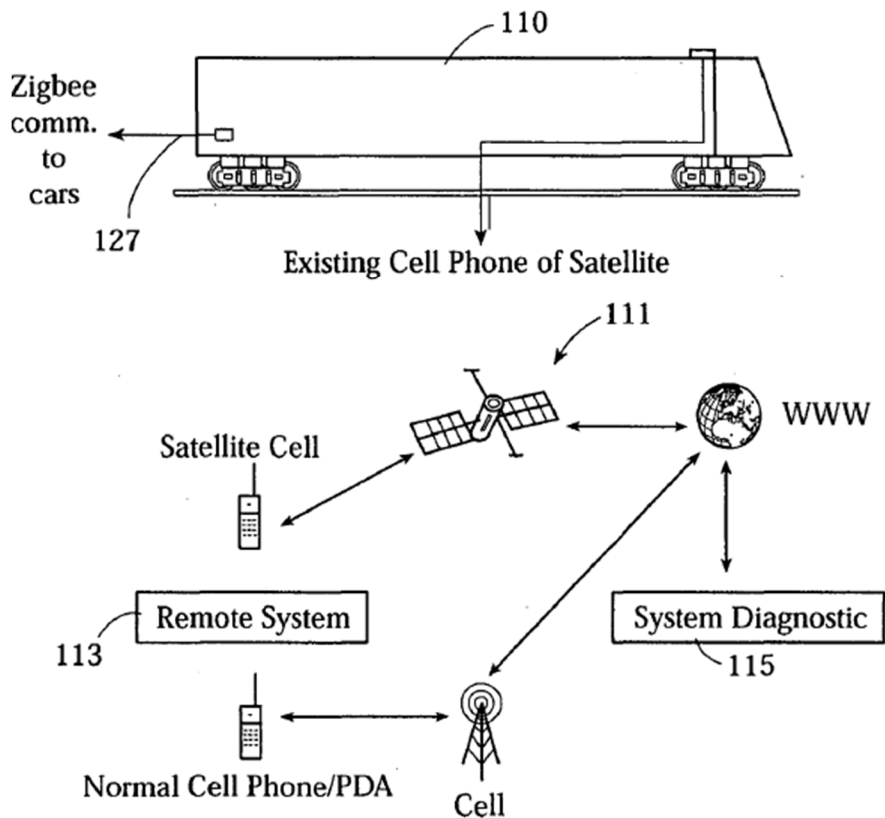


FIG. 2

## IX. OPINION ON GROUNDS OF UNPATENTABILITY

### A. Legal Principles of Anticipation

57. I have been informed that, under 35 U.S.C. § 102, novelty is a requirement for patentability. I have further been informed that a patent claim lacks novelty and is anticipated when a single prior art reference discloses all the features of a claim and enables one of ordinary skill in the art to make and use the invention.

### B. Legal Principles of Obviousness

58. I have been told that under 35 U.S.C. § 103(a), “[a] patent may not be obtained though the invention is not identically disclosed or described as set forth in Section 102, if the differences between the subject matter sought to be patented

and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.”

59. When considering the issues of obviousness, I have considered each of the following “Graham factors”:

- (a) the scope and content of the prior art;
- (b) the differences between the prior art and the claims at issue;
- (c) the level of ordinary skill in the pertinent art
- (d) evidence of secondary indicia of non-obviousness (if available).

60. I have been told that the relevant time for considering whether a claim would have been obvious to a PHOSITA is the time of alleged invention.

61. I have been told that a reference may be modified or combined with other references or with the PHOSITA’s own knowledge if the person would have found the modification or combination obvious. A PHOSITA is presumed to know all relevant prior art, and the obviousness analysis may consider the inferences and creative steps that a PHOSITA would employ.

62. In determining whether a prior-art reference could have been combined with another prior-art reference or other information known to a person having ordinary skill in the art, I have been told that the following principles may be considered:

- (a) a combination of familiar elements according to known methods is likely to be obvious if it yields predictable results;
- (b) the substitution of one known element for another is likely to be obvious if it yields predictable results;
- (c) the use of a known technique to improve similar items or methods in the same way is likely to be obvious if it yields predictable results;
- (d) the application of a known technique to a prior art reference that is ready for improvement is likely obvious if it yields predictable results;
- (e) any need or problem known in the field and addressed by the reference can provide a reason for combining the elements in the manner claimed;
- (f) a person of ordinary skill often will be able to fit the teachings of multiple references together like a puzzle; and
- (g) the proper analysis of obviousness requires a determination of whether a person of ordinary skill in the art would have a “reasonable expectation of success”—not “absolute predictability” of success—in achieving the claimed invention by combining prior art references.

63. I have been told that whether a prior art reference renders a patent claim unpatentable as obvious is determined from the perspective of a PHOSITA. Further, I have been told that while there is no requirement that the prior art

contain an express suggestion to combine known elements to achieve the claimed invention, a suggestion to combine known elements to achieve the claimed invention may come from the prior art as a whole or individually, as filtered through the knowledge of one skilled in the art. I have also been told that the inferences and creative steps a PHOSITA would employ are also relevant to the determination of obviousness.

64. I have been told that when a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the same field or in another. If a PHOSITA can implement a predictable variation and would see the benefit of doing so, that variation is likely to be obvious. In many fields, there may be little discussion of obvious combinations, and in these fields market demand—not scientific literature—may drive design trends. When there is a design need or market pressure and there are a finite number of predictable solutions, a PHOSITA has good reason to pursue those known options.

65. I have been told that there is no rigid rule that a reference or combination of references must contain a “teaching, suggestion, or motivation” to combine references. But I also have been told that the “teaching, suggestion, or motivation” test can be a useful guide in establishing a rationale for combining elements of the prior art. This test poses the question whether there is an express or

implied teaching, suggestion, or motivation to combine prior art elements in a way that yields the claimed invention and avoids impermissible hindsight analysis.

**C. Ground 1: Claims 1–7, 10–18, and 20–22 are unpatentable under 35 U.S.C. § 103(a) as obvious over LeFebvre**

66. In my opinion, LeFebvre—as it would have been understood by a PHOSITA—discloses each and every limitation of claims 1–7, 10–18, and 20–22. The claims therefore would have been obvious to a PHOSITA.

67. LeFebvre’s entire disclosure is directed to a railcar monitoring system. To the extent that LeFebvre can be viewed as disclosing different embodiments of a railcar monitoring system, those embodiments are very similar to one another, and share most if not all of the features recited by claims 1–7, 10–18, and 20–22. In my opinion, a PHOSITA could have, and would have, combined the teachings of LeFebvre as set forth in detail below. It is also my opinion that a PHOSITA could have combined the teachings of LeFebvre as discussed below with a reasonable expectation of success.

68. It is also my opinion that LeFebvre provides an enabling disclosure of every element of these claims. LeFebvre’s disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre’s invention (i.e., could have implemented the railcar monitoring systems and sensing/monitoring devices disclosed by LeFebvre) without undue experimentation. A PHOSITA could have

followed the teachings of LeFebvre to arrive at the claimed systems and devices with a reasonable expectation of success.

69. More generally, the elements of claims 1–7, 10–18, and 20–22 are all well-known in the art, and would have been fully understood by a PHOSITA. The art to which these claims are directed—systems and sensors for monitoring operational parameters of railcars—is predictable, involving simple mechanical components and widely available, off-the-shelf electronic components. The recited method steps (collecting data from sensors, applying heuristics to detect deviations from normal operating conditions, using a wireless network to transmit an alarm message, etc.) have been known and used in the prior art for decades, as I explained above in Section V, paragraphs 29–41, which are incorporated here by reference. For at least these reasons, it is my opinion that a PHOSITA could have made any required adjustments or modifications to LeFebvre’s disclosed systems and sensors with a reasonable expectation of success and without undue experimentation.

## **1. Independent Claim 1**

### **a. Claim 1 Preamble: “A method of monitoring operational characteristics of a railcar comprising the steps of:”**

70. I have been informed by counsel that claim preambles are generally not limiting when the content of the claimed preamble is an “intended use.” I have been informed by counsel that preambles are generally statements of intended use

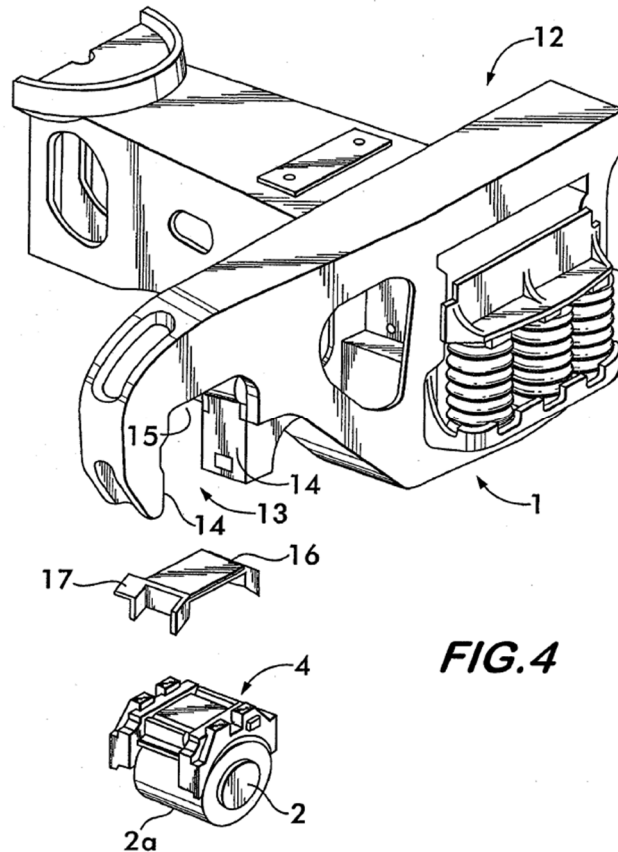
when the body of a claim fully sets forth all the limitations of the claimed invention, and the preamble merely states the purpose or intended use of the invention. Here the preamble merely states “[a] method of monitoring operational characteristics of a railcar.” In my opinion, this preamble is entirely a statement of intended use, and so should not be given patentable weight.

71. Even so, if the preamble was limiting, LeFebvre discloses the entire preamble. Specifically, LeFebvre discloses “a monitoring system for railroad trains and the like, and more particularly a system that uses an instrumented roller bearing adapter pad to detect the occurrence and cause of poor performance at wheel set, truck, freight car or train level.” EX1005, ¶ [0001].

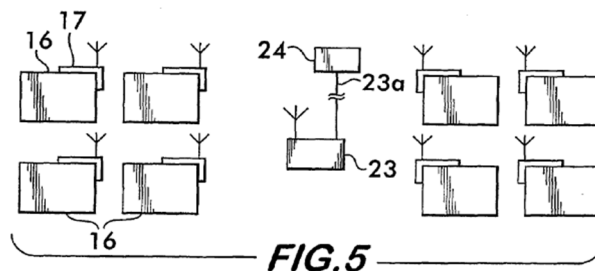
**b. Limitation 1(a): “a. receiving data or processed information regarding said operational characteristic from one or more sensing units on said railcar, said sensing units monitoring an operational characteristic of said railcar”**

72. LeFebvre discloses a railcar monitoring system comprising a plurality of instrumented pads 16, each of which comprises one or more sensors that measure operational parameters of the railcar. EX1005, ¶¶ [0019], [0023], [0052]. The sensors may comprise, for example, one or more temperature sensors. EX1005, (57) Abstract, ¶¶ [0021], [0033], [0058]. A PHOSITA would understand that LeFebvre’s instrumented pad is a “sensing unit” in the parlance of the ’673 Patent.

73. Each instrumented pad 16 is a separate device that is mounted on the railcar. Specifically, each pad is mounted upon the upper surface of a wheel bearing adapter 4, as shown in Fig. 4. EX1005, ¶ [0019].



74. Figure 5 of LeFebvre depicts an exemplary embodiment with a plurality of instrumented pads 16, where each instrumented pad is attached to a different wheel bearing adapter. EX1005, ¶ [0039], Fig. 5.



75. Each instrumented pad 16 communicates wirelessly with a data control unit 23, which is mounted on the railcar body. EX1005, ¶ [0024]; Fig. 5.

76. A PHOSITA would thus understand that LeFebvre’s data control unit receives data from the instrumented pads (i.e., sensing units), as required by Limitation 1(a). A PHOSITA would also understand that the data control unit performs steps (b)–(d) of claim 1, as I will explain in further detail below.

**c. Limitation 1(b): “b. applying a heuristic to said received data to determine deviations from nominal operating conditions”**

77. LeFebvre’s data control unit uses “inference engine techniques” (i.e., heuristics) to analyze the data it receives from the instrumented pads. EX1005, ¶¶ [0036], [0056], [0095].

78. “As an aggregator of information, [the data control unit] is programmed to compare information from all of the trucks on the railcar and draws inferences from them as to the status of the car, for example, the data control unit uses inference engine techniques to identify unsatisfactory behavior such as swaying, bouncing or even partial derailment.” EX1005, ¶ [0036]. “Given that more than one instrumented pad may report misbehavior, then the components of the inference engine in the data control unit take responsibility for making assessments for the whole truck and ultimately for the freight car.” EX1005, ¶ [0056].

79. LeFebvre teaches that heuristics can be applied to the collected data to infer the presence of numerous conditions, including:

- bearing defects (§§ [0058]–[0059]),
- wheel defects (§ [0060]),
- wheel derailment (§ [0061]),
- truck hunting (§ [0062]),
- displaced roller bearing adapters (§ [0064]), and
- brake performance and status (§ [0065]), among others.

LeFebvre’s data control unit may detect a wheel derailment condition by looking for a high frequency, periodically repeating load and “a similar signal from both wheels in the wheel set.” *Id.*, §§ [0060]–[0061]. Similarly, LeFebvre’s data control unit may detect track defects by “monitoring the vertical loads in the instrumented pads and comparing these between wheel sets.” *Id.*, § [0066]. LeFebvre also discloses simple heuristics to monitor brake performance and status: “excessively high brake loads indicating brakes may cause wheels to bind, excessively low brake loads indicating the brakes are not working properly.” *Id.*, § [0065]. All of these are examples of well-known heuristics that would have been familiar to a PHOSITA.

**d. Limitation 1(c): “c. assigning a severity level to said deviations from nominal operating conditions”**

80. LeFebvre’s system does not generate an alert for every detected deviation from nominal operating conditions. To the contrary, LeFebvre teaches that the instrumented pad should report an error to the data control unit *only* if a deviation is detected *and* “the magnitude is sufficient to cause alarm.” EX1005, ¶ [0055]. Likewise, the data control unit determines whether the railcar components “are behaving *sufficiently poorly* that a report to the central data handling location or owner or operator or locomotive is needed. If so, then the report can be sent.” *Id.*, ¶ [0095].

81. LeFebvre also claims a “method of monitoring performance of [railcars]” that includes “identifying performance behavior derived from said signals *considered to be sufficient to cause alarm* and communicating to the prime mover messages identifying *only the performance behavior sufficient to cause alarm*.” EX1005, claim 28 (emphasis added). Similarly, the system described in LeFebvre’s claim 9 includes “means for communicating to said remote receiver *only values indicative of critical departures of the performance criteria* for a particular sensor in a particular railcar.” EX1005, claim 9 (emphasis added). *See also id.*, Claims 12 and 21.

82. A PHOSITA would therefore understand that LeFebvre’s system distinguishes between (a) deviations from expected operating conditions that *are*

*not* severe enough to raise an alarm; and (b) deviations that *are* severe enough to raise an alarm.

83. In my opinion, LeFebvre’s data control unit therefore performs the step recited in Limitation 1(c): it assesses the severity of detected deviations, and categorizes the deviations according to their level of severity. And as I will explain in further detail below, the data control unit transmits an alarm message to a remote receiver if, and *only* if, the deviation is severe enough to warrant an alarm.

**e. Limitation 1(d): “d. determining an alarm condition based on said assigned severity level.”**

84. In LeFebvre’s system, the data control unit is ultimately responsible for determining whether an alarm message should be generated:

The data control unit then performs the assessments described above for the inference engine to check if the freight car, its trucks or wheels or axles are behaving *sufficiently poorly* that a report to the central data handling location or owner or operator or locomotive is needed. If so, then the report can be sent.

EX1005, ¶ [0095] (emphasis added).

85. If the detected condition is sufficiently severe that an alarm is warranted, the data control unit will send an alarm message upstream (i.e., to the locomotive and/or a remote data handling location). EX1005, ¶ [0095]. “When

serious trouble is inferred, then messages are sent via the communications link 23a, 24 to the locomotive, etc.” EX1005, ¶ [0056].

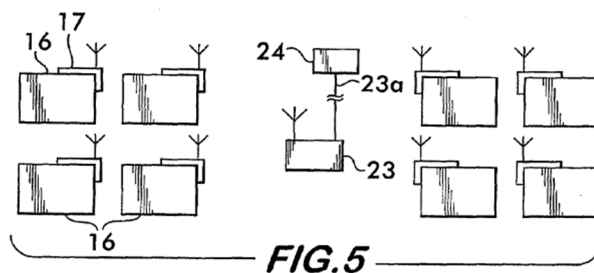
**f. Claim 1 is obvious over LeFebvre**

86. LeFebvre therefore discloses or renders obvious every element of independent claim 1, in detail, and in the same arrangement as required by the claim. Additionally, it is my opinion that LeFebvre provides an enabling disclosure of every element of claim 1. LeFebvre’s disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre’s invention (i.e., could have implemented the railcar monitoring system disclosed by LeFebvre) without undue experimentation. To the extent that different elements of claim 1 are described in different portions of LeFebvre’s specification, a PHOSITA would have immediately understood—based upon the disclosure of LeFebvre—that they could be combined in the manner I have described above. It is therefore my opinion that claim 1 is obvious over LeFebvre.

**2. Dependent Claim 2: “The method of claim 1 further comprising the initial step of establishing wireless communication with said one or more remote sensing units.”**

87. In LeFebvre’s system, the instrumented pads (i.e., the remote sensing units) communicate wirelessly with the data control unit (i.e., the processing unit). EX1005, ¶¶ [0024], [0031]. The instrumented pads and the data control unit on each railcar form a wireless mesh network, in which each instrumented pad is

capable of exchanging data with each other instrumented pad and with the data control unit.



88. For example, “[i]n the embodiment shown in FIG. 5, each instrumented pad **16** has its own microprocessor and radio. This arrangement is intended to use a protocol for networking which allows the messages to be passed between pads on their way to and from the digital communications unit **23**.”

EX1005, ¶ [0039]; Fig. 5. The wireless networking protocol may be a mesh networking protocol conforming to the IEEE802.15.4 standard, such as Zigbee.

EX1005, ¶ [0031]. The IEEE802.15.4 standard protocol “allow[s] the instrumented pads and data control units to establish a network of connections without external intervention.” EX1005, ¶ [0032].

89. It is therefore my opinion that LeFebvre discloses or renders obvious every element of claim 2.

**3. Dependent Claim 3: “The method of claim 2 wherein said one or more remote sensing units form a mesh network.”**

90. See Dependent Claim 2, Section IX.C.2 above. For the same reasons I have discussed above with respect to Dependent Claim 2, it is also my opinion that

each limitation of Dependent Claim 3 is obvious in view of LeFebvre. Specifically, the opinions I have expressed in paragraphs 87–89 above also reflect my opinions with respect to Dependent Claim 3, and are incorporated here by reference.

**4. Dependent Claim 4: “The method of claim 2 wherein steps a-d are executed by a processing unit located on said railcar.”**

91. As I have explained in detail above with respect to Independent Claim 1, LeFebvre’s data control unit is mounted on the railcar and performs each step (a)–(d) of claim 1. *See* Limitations 1(a)–1(d), discussed in Sections IX.C.1.b, IX.C.1.c, IX.C.1.d, and IX.C.1.e, above, each of which is incorporated here by reference. Specifically, each data control unit comprises a microprocessor that carries out each step (a)–(d). *See* Section IX.C.17 below, which is incorporated here by reference.

**5. Dependent Claim 5: “The method of claim 4 wherein said processing unit located on said railcar is a part of said mesh network.”**

92. *See* Dependent Claim 2, Section IX.C.2 above. For the same reasons I have discussed above with respect to Dependent Claim 2, it is also my opinion that each limitation of Dependent Claim 5 is obvious in view of LeFebvre. Specifically, the opinions I have expressed in paragraphs 87–89 above also reflect my opinions with respect to Dependent Claim 5, and are incorporated here by reference.

**6. Dependent Claim 6: “The method of claim 2 further comprising the step of transmitting said alarm condition to a location remote from said railcar.”**

93. LeFebvre discloses that the data control unit (i.e., a processing unit) is capable of transmitting data and alarm messages to a remote location. *See* Section IX.C.1.e above, which is incorporated here by reference.

94. “[T]he data control unit 23 passes messages on to the communications device 24 for onward transmission to the locomotive or to other remote receivers.” EX1005, ¶ [0038]. For communication with remote sources, the communications device may comprise, for example, “a cellular or satellite radio system.” EX1005, ¶ [0025]. The remote receiver may be, for example, a “remote data handling service” (EX1005, ¶ [0052]) or a “central data handling location” (EX1005, ¶ [0095]).

95. It is therefore my opinion that LeFebvre discloses or renders obvious every element of claim 6.

**7. Dependent Claim 7: “The method of claim 2 further comprising the step of transmitting said data received from said one or more sensing units to a location remote from said railcar.”**

96. LeFebvre discloses that the data control unit (i.e., a processing unit) is capable of transmitting data and alarm messages to a remote location. *See* Limitation 1(d), Section IX.C.1.e above, and Dependent Claim 6, Section IX.C.6 above, both of which are incorporated here by reference.

97. In LeFebvre’s system, an alarm message sent to the remote receiver includes associated data (i.e., “signals” or “values”) collected from one or more sensors, that indicate the presence of the severe condition or failure being reported.

*See, for example:*

- LeFebvre’s Claim 9 (“communicating to said remote receiver only *values* indicative of critical departures of the performance criteria for a particular sensor in a particular railcar”);
- LeFebvre’s Claim 12 (“logic circuitry ... for communicating *values derived by said sensors* to a remote location, said values being communicated only upon a determination by the logic circuitry that the values are indicative of a potential operating failure”);
- LeFebvre’s Claim 21 (“identifying vibration levels indicative of potential failure and communicating *said signals of vibration level* indicative of potential failure to said remote location.”).

98. Each of these passages states that an alarm message sent to a remote receiver (e.g., to a central data handling location) will include associated data collected from one or more sensors—specifically, data that indicate the presence of an actual or imminent failure condition that is severe enough to warrant an alarm.

99. It is therefore my opinion that LeFebvre discloses or renders obvious every element of claim 7.

## 8. Independent Claim 10

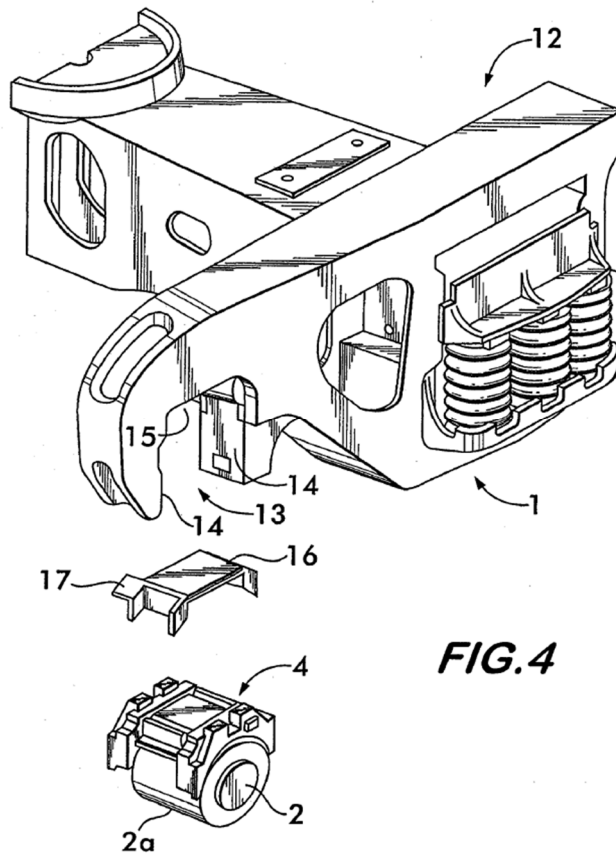
### a. Claim 10 Preamble: “A method of monitoring a temperature of a desired part of a railcar, comprising:”

100. See Claim 1 Preamble, Section IX.C.1.a above. For the same reasons I have discussed above with respect to the Claim 1 Preamble, it is my opinion that the Claim 10 Preamble is also obvious in view of LeFebvre. Specifically, the opinions I have expressed in paragraphs 70–71 above also reflect my opinions with respect to the Claim 10 Preamble, and are incorporated here by reference.

### b. Limitations 10(a) and 10(b): “(a) sensing the temperature of a part of the railcar other than the desired part by use of a temperature sensor in thermal communication with said other part [and] (b) determining the temperature of the desired part by use of the temperature sensed in step (a)”

101. As discussed above, LeFebvre discloses a railcar monitoring system comprising a plurality of instrumented pads 16, each of which can comprise one or more temperature sensors. See Limitation 1(a), discussed in Section IX.C.1.b above, which is incorporated here by reference. The temperature sensor can be used, for example, to monitor the temperature of a wheel bearing associated with the instrumented pad. EX1005, ¶¶ [0033], [0058].

102. As shown in Figure 4, LeFebvre’s instrumented pad 16 measures the temperature of wheel bearing adapter 4, which can be used to infer the temperature of wheel bearing 2a. EX1005, ¶ [0019], Fig. 4.



103. See also EX1005, ¶ [0020] (“Each bearing transmits the ... heat that it may generate through the adapter to the pad”). LeFebvre therefore discloses sensing the temperature of a part of the railcar (i.e., the bearing adapter **4**) other than the desired part (i.e., the wheel bearing **2a**) by use of a temperature sensor in thermal communication with said other part (i.e., the bearing adapter **4**).

104. Similarly, LeFebvre’s claim 8 states that “the temperature responsive sensor is *disposed adjacent to the bearing.*” *Id.*, Claim 8 (emphasis added). In other words, LeFebvre’s temperature sensor measures an adjacent portion of the railcar (i.e., “a part of the railcar than the desired part”) and this measurement is

used to infer the temperature of the wheel bearing itself (i.e., “the desired part”).

LeFebvre does not directly attach a sensor to the wheel bearing itself.

105. In my experience, directly attaching a temperature sensor to a rotating bearing is usually impractical. While not impossible, it is more difficult and expensive to attach sensors to moving components, and especially components such as bearings that can spin rapidly. In my experience, it is much more common to indirectly measure the temperature of a rotating mechanical component (e.g., a wheel bearing) by attaching a temperature sensor to a nearby, stationary component that is in thermal communication with the rotating component. This arrangement has been commonplace in industry for decades, and would be familiar to any PHOSITA. Additionally, if a temperature sensor is placed in direct contact with the inner bearing race, the sensor is likely to be damaged in an unpredictable way if a catastrophic bearing failure occurs. Most dangerously, this could result in the sensor becoming detached from the failed bearing and, in effect, measuring the ambient air temperature—completely masking the failure. This is an additional reason why it was common practice to indirectly measure bearing parameters such as temperature and acceleration.

106. For example, US 2005/0194497 to Matzan (“Matzan”) discloses a system “for automatic detection of overheated wheel bearings of railroad cars and carriages.” EX1018, (57) Abstract. Matzan teaches that “[s]ignals representing the

temperature of such bearings are generated by temperature sensors that are *installed in close proximity of the wheel bearings.*” *Id.* Matzan merely provides confirmation and support for my opinion that this practice is commonplace in industry and that its advantages would be familiar to any PHOSITA.

107. Accordingly, a PHOSITA who was interested in measuring the temperature of a wheel bearing on a railcar would have been motivated to attach the temperature sensor to a stationary component of the railcar adjacent to the wheel bearing (rather than to the wheel bearing itself). The PHOSITA would have understood that this arrangement is mechanically simple, conventional, and easier to implement than attaching a sensor to the bearing directly.

**c. Limitation 10(c): “(c) determining if said temperature of the desired part is outside an acceptable range of temperatures”**

108. LeFebvre teaches that the temperature of the wheel bearing should be monitored to determine if it is outside an acceptable range. “[I]t is important for safety that a bearing does not become overheated.” EX1005, ¶ [0033]. To accomplish this goal, “[a] temperature sensor in instrumented pad 16 monitors relative changes in temperature against other bearings and provides an alarm threshold.” EX1005, ¶ [0058].

**d. Limitation 10(d): “(d) transmitting an alarm if in step (c) it is determined that the temperature of the desired part is outside an acceptable range.”**

109. LeFebvre teaches that an alarm message is generated if a monitored parameter, such as temperature, is outside the expected range and the magnitude of the deviation is sufficient to cause alarm. *See* Limitation 1(d), section IX.C.1.e above, which is incorporated here by reference.

**e. Claim 10 is obvious over LeFebvre**

110. LeFebvre therefore discloses or renders obvious every element of independent claim 10, in detail, and in the same arrangement as required by the claim. Additionally, it is my opinion that LeFebvre provides an enabling disclosure of every element of claim 10. LeFebvre’s disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre’s invention (i.e., could have implemented the railcar monitoring system disclosed by LeFebvre) without undue experimentation. To the extent that different elements of claim 10 are described in different portions of LeFebvre’s specification, a PHOSITA would have immediately understood—based upon the disclosure of LeFebvre—that they could be combined in the manner I have described above. It is therefore my opinion that claim 10 is obvious over LeFebvre.

**9. Dependent Claim 11: “A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, further comprising the**

**step of determining the temperature of the ambient air, which temperature is used in the determination of step (b).”**

111. LeFebvre discloses that the railcar may comprise a second temperature sensor for monitoring the ambient air temperature. EX1005, ¶ [0037]. Specifically, LeFebvre discloses that “if desired, detectors of factors such as ambient temperature and humidity (rain, snow and icing) can be built into the communication device 24 or the data control unit 23.” EX1005, ¶ [0037].

112. LeFebvre teaches that the ambient temperature measurement is incorporated into the “distributed inference engine,” which performs statistical analysis of the collected data. EX1005, ¶ [0037]. LeFebvre also discloses that information about the ambient temperature is sent from the data control unit to the instrumented pads. EX1005, ¶ [0093]. Based upon this disclosure, a PHOSITA would have understood that LeFebvre’s system uses the ambient temperature to calibrate the temperature data received from the sensors, as required by claim 11.

113. More generally, a PHOSITA would understand that information about ambient temperature is useful to calibrate readings from temperature sensors, particularly in an outdoor environment. The only plausible reason that LeFebvre’s system would collect information about ambient temperature, and then transmit it to the instrumented pads (*see* EX1005, ¶ [0093]), is to use the ambient temperature data to calibrate the readings from the temperature sensors attached to the instrumented pads.

114. LeFebvre, in view of the general knowledge possessed by a PHOSITA, therefore discloses or renders obvious every element of dependent claim 11.

**10. Dependent Claim 12: “A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, wherein steps (a) through (d) are carried out by a single unit attached to said railcar.”**

115. Each step (a) through (d) of claim 10 is carried out by LeFebvre’s instrumented pad.

116. Limitations 10(a) and 10(b): The instrumented pad can include a temperature sensor, as discussed extensively above. *See, e.g.*, Limitation 1(a), discussed in Section IX.C.1.b above, and Limitations 10(a) and 10(b), discussed in Section IX.C.8.b above, all of which are incorporated here by reference.

117. Limitation 10(c): LeFebvre’s instrumented pad includes a microprocessor unit (EX1005, ¶ [0021]), and can use heuristics to determine the presence of an alarm condition. EX1005, ¶¶ [0054]–[0055]. Specifically, each instrumented pad collects measurements, structures those measurements as a time series, and uses an inference engine (i.e., heuristics) to perform statistical analysis of the measurements and detect actual or potential issues (e.g., excessive bearing temperature). EX1005, ¶¶ [0054], [0058]. *See* Limitation 10(c), discussed in Section IX.C.8.c above, which is incorporated here by reference.

118.            Limitation 10(d): If an issue is detected by the instrumented pad, and “the magnitude is sufficient to cause alarm,” an alarm message with the relevant data is passed upstream to the data control unit. EX1005, ¶ [0055].

119.            It is therefore my opinion that LeFebvre discloses or renders obvious every element of dependent claim 12.

**11.    Dependent Claim 13: “The method of claim 1 wherein steps (a) through (d) can be carried out at different event engines distributed among at least two of said sensor units, a communication management unit, and a mobile or land base station.”**

120.            LeFebvre utilizes a “distributed inference engine” to process and analyze the data collected from sensors on each railcar. EX1005, ¶ [0053].

LeFebvre’s system “share[s] the essential functions between the microprocessors at the instrumented pads and at the data control unit 23.” *Id.* “[P]art of the data analysis is done at the pads and only relevant information is transmitted to the data control unit from the pads for further analysis and recognition of faults.” *Id.*

121.            A PHOSITA would therefore understand that in LeFebvre’s system, a first pass analysis of sensor data—corresponding to steps (a)–(d) of claim 10, as described with respect to Dependent Claim 12 in Section IX.C.10 above—is conducted by the instrumented pads located on each railcar. If a potential fault condition is detected, the relevant data is passed upstream to the data control unit, where further analysis is conducted. LeFebvre therefore discloses a system wherein data analysis is conducted by at least two different event engines, one of which is

located on the instrumented pads, and another of which is located on the data control unit. A PHOSITA would understand that these two systems work in tandem to form what LeFebvre calls a “distributed inference engine.” EX1005, ¶ [0053]. Additionally, in LeFebvre’s system, each railcar is equipped with a data control unit that transmits data and alarm messages to a remote receiver. *See* my discussion of Dependent Claim 6 and Dependent Claim 7, Sections IX.C.6 and IX.C.7 above, which are incorporated here by reference. The remote receiver may be, for example, a base station located in the locomotive or a central data handling location. EX1005, ¶¶ [0003], [0038], [0052], [0095]. As I have explained above, an alarm message sent to the remote receiver includes associated data (i.e., “signals” or “values”) collected from one or more sensors, that indicate the presence of the severe condition or failure being reported. *See* IX.C.7 above. LeFebvre therefore additionally discloses a remote receiver that carries out at least step (a) of claim 1.

122. LeFebvre therefore discloses, or at least renders obvious, an embodiment wherein each of steps (a)–(d) are carried by a plurality of instrumented pads; each of steps (a)–(d) are carried out by a data control unit; and step (a) is additionally carried out by a remote receiver. It is therefore my opinion that LeFebvre discloses or renders obvious every element of dependent claim 13.

## 12. Independent Claim 14

**a. Claim 14 Preamble: “A method for monitoring the operation of a railcar performed by a communication management unit disposed on said railcar comprising the steps of:”**

123. See my discussion of the Claim 1 Preamble in Section IX.C.1.a above, which is incorporated here by reference. A PHOSITA would understand that LeFebvre’s data control unit is a “communication management unit” that performs each step required by claim 14, as explained in detail below.

**b. Limitation 14(a): “a. wirelessly receiving data from one or more sensing units which periodically collect readings from one or more sensors disposed on said railcar”**

124. LeFebvre discloses a railcar monitoring system comprising a plurality of instrumented pads (i.e., sensing units), each of which comprises one or more sensors that measure operational parameters of the railcar. See Limitation 1(a), Section IX.C.1.b above, which is incorporated here by reference. As I have explained above, each instrumented pad communicates wirelessly with a data control unit mounted on the railcar body.

125. If an issue is detected by the instrumented pad, and “the magnitude is sufficient to cause alarm,” a message with the relevant data is passed upstream to the data control unit. EX1005, ¶ [0055]. A PHOSITA would understand that LeFebvre’s data control unit is a “processing unit” in the parlance of the ’673 Patent.

126. LeFebvre manages the power consumption of its instrumented pad by periodically placing the device into a low-power, or “standby,” state. EX1005, ¶¶ [0034]–[0035]. “[I]n operation, the microprocessor on an instrumented pad 16 is normally in a passive, low power state, but is programmed to switch on briefly periodically.” EX1005, ¶ [0034]. “[S]hould the pads detect indications of fault or impending failure, the microprocessor on the pad may be programmed to switch on the radio which it controls and send an appropriate message via the radio to the data control unit 23.” *Id.*, ¶ [0035]. “In the absence of such a problem, the pad microprocessor follows its given schedule which would normally result in its being in a low powered state most of the time.” *Id.*

127. The microprocessor on the instrumented pad awakens at periodic intervals to process sensor data and, if appropriate, initiate a radio transmission. EX1005, ¶ [0034]; *see also* EX1005, Claim 22 (“each pad having an associated microprocessor, each microprocessor being programmed to a periodically active state to scan the sensed data for indications of potential failure”).

**c. Limitation 14(b): “b. heuristically analyzing said received data to determine if an actual failure exists on said railcar or to predict potential or imminent failures based on a statistical analysis of said received data”**

128. In LeFebvre’s system, the data control unit acts as an “aggregator of information”, collecting data from each of the instrumented pads on the railcar. EX1005, ¶¶ [0036], [0056], [0095]. The data control unit then uses “inference

engine techniques” (i.e., heuristics) to analyze the collected data. EX1005, ¶¶ [0036], [0056], [0095]. *See* Limitation 1(b), Section IX.C.1.c above, which is incorporated here by reference.

129. For example, LeFebvre discloses the use of heuristics, based upon data collected from one or more sensor units, to determine the existence of *actual* failure conditions. EX1005, ¶¶ [0058]–[0066]. For example, heuristics may be used to identify the existence of wheel damage such as “a flat spot or shelled wheel tread,” EX1005, ¶ [0060], or a wheel derailment. EX1005, ¶ [0061]

130. LeFebvre also discloses the use of heuristics based upon data collected from one or more sensor units to predict *potential or imminent* failures based upon a statistical analysis of the collected data. EX1005, ¶¶ [0058]–[0066]. For example, LeFebvre discloses that heuristics may be used to identify “long term trends” in wheel bearing temperature, “avoiding a potential bearing burn off and possible derailment.” EX1005, ¶ [0058]. LeFebvre additionally discloses that “[s]pecific bearing defects can be inferred from frequency spectrum analysis.” EX1005, ¶ [0059]. LeFebvre teaches that “identifying a failing bearing in its early stages is important in preventative maintenance programs.” *Id.*

**d. Limitation 14(c): “c. communicating the results of said analysis to an off-railcar location.”**

131. LeFebvre discloses that the data control unit (i.e., processing unit) is capable of transmitting data and alarm messages to a remote location. *See*

Dependent Claim 6, Section IX.C.6 above, which is incorporated here by reference.

**e. Claim 14 is obvious over LeFebvre**

132. LeFebvre therefore discloses or renders obvious every element of independent claim 14, in detail, and in the same arrangement as required by the claim. Additionally, it is my opinion that LeFebvre provides an enabling disclosure of every element of claim 14. LeFebvre's disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre's invention (i.e., could have implemented the railcar monitoring system disclosed by LeFebvre) without undue experimentation. To the extent that different elements of claim 14 are described in different portions of LeFebvre's specification, a PHOSITA would have immediately understood—based upon the disclosure of LeFebvre—that they could be combined in the manner I have described above. It is therefore my opinion that claim 14 is obvious over LeFebvre.

**13. Dependent Claim 15**

**a. Limitation 15(a): “The method of claim 14 wherein each of said sensing units can make a determination of an alarm condition based on data collected by the sensing unit, said method further comprising the step of: a. wirelessly receiving notice of said alarm condition from said sensing unit”**

133. LeFebvre's instrumented pad collects data from its associated sensors, analyzes the collected data using heuristics, determines whether an alarm should be raised, and (if necessary) sends an alarm message upstream to the data control unit.

*See* Dependent Claim 12, Section IX.C.10 above, which is incorporated here by reference.

134. LeFebvre's instrumented pads communicate wirelessly with the data control unit located on the same railcar, and send alarms via this wireless communication link. *See* Dependent Claim 2, Section IX.C.2 above, and Limitation 14(a), Section IX.C.12.b above, both of which are incorporated here by reference.

**b. Limitation 15(b): “b. communicating said alarm condition to an off-railcar location.”**

135. *See* Limitation 14(c), Section IX.C.12.d above, which is incorporated here by reference.

136. It is therefore my opinion that LeFebvre discloses or renders obvious every element of dependent claim 15.

**14. Dependent Claim 16**

**a. Limitation 16(a): The method of claim 14 further comprising the steps of: a. making a determination of an alarm condition based on data received from two or more of said sensing units”**

137. LeFebvre's data control unit aggregates data from a plurality of instrumented pads, and uses heuristics to analyze the aggregated data and determine if an alarm should be raised. *See* Limitation 14(b), Section IX.C.12.c above, which is incorporated here by reference.

**b. Limitation 16(b): “b. communicating said alarm condition to an off-railcar location.”**

138. If the detected condition is sufficiently severe that an alarm is warranted, the data control unit will send an alarm message upstream (i.e., to the locomotive and/or a remote data handling location). *See* Limitation 1(d), Section IX.C.1.e above, which is incorporated here by reference.

139. It is therefore my opinion that LeFebvre discloses or renders obvious every element of dependent claim 16.

**15. Dependent Claim 17: “The method of claim 14 further comprising the step of placing said one or more sensing units in a stand-by state when said one or more sensing units is not reading data from any of said sensors or transmitting data.”**

140. LeFebvre manages the power consumption of its instrumented pad by periodically placing the device into a low-power, or “standby,” state. The instrumented pad periodically awakens from the standby state to read data from the sensors and, if warranted, transmit an alarm message upstream. *See* Limitation 14(a), Section IX.C.2 above, which is incorporated here by reference.

141. It is therefore my opinion that LeFebvre discloses or renders obvious every element of dependent claim 17.

**16. Dependent Claim 18: “The method of claim 14 further comprising the step of joining a mesh network consisting of one or more sensing units located on said railcar.”**

142. *See* Dependent Claim 2, Section IX.C.2 above. For the same reasons I have discussed above with respect to Dependent Claim 2, it is also my opinion that

each limitation of Dependent Claim 18 is obvious in view of LeFebvre.

Specifically, the opinions I have expressed in paragraphs 87–89 above also reflect my opinions with respect to Dependent Claim 18, and are incorporated here by reference.

## **17. Dependent Claim 20**

**a. Limitation 20(a): “The system of claim 14 further comprising the steps of: a. saving data received from said one or more sensing units in memory”**

143. LeFebvre discloses that each data control unit contains a microprocessor. EX1005, ¶ [0024].

144. Although not expressly stated by LeFebvre, a PHOSITA would understand that each data control unit includes memory, which is used to store data received from the instrumented pads. Specifically, LeFebvre discloses that the data control unit receives data from instrumented pads located on the same railcar, analyzes the collected data using heuristics, determines whether an alarm should be raised, and (if necessary) sends an alarm message upstream to the locomotive or a remote location. *See* Independent Claim 1, Section IX.C.1 above, the entirety of which is incorporated here by reference. A PHOSITA would understand that data received from the instrumented pads is stored in some form of memory (e.g., in RAM or on a hard drive) on the data control unit until it is processed by the data control unit’s microprocessor.

145. Additionally, I will explain in greater detail below in Limitation 20(b), LeFebvre discloses heuristics that involve comparing currently collected data against data collected during a previous time period, which would necessarily be stored in memory on the data control unit.

**b. Limitation 20(b): “b. comparing data received with said saved data to identify trends or deviations from normal readings of said data stored in memory.”**

146. LeFebvre discloses heuristics that involve comparing currently collected data against stored data collected during a previous time period.

147. For example, LeFebvre teaches that the condition of a wheel bearing may be determined by “monitor[ing] relative changes in temperature against other bearings and provid[ing] an alarm threshold or long term trends to link to bearing condition.” EX1005, ¶ [0058]. To identify “relative changes in temperature” or to generate a “long term trend,” currently collected data is compared with data collected during an earlier time period.

148. It is therefore my opinion that LeFebvre discloses or renders obvious every element of dependent claim 20.

**18. Independent Claim 21**

**a. Claim 21 Preamble: “A method for monitoring the operation of a railcar comprising:”**

149. *See* the Claim 1 Preamble, which I have discussed in Section IX.C.1.a above. For the same reasons I have discussed above with respect to the Claim 1

Preamble, it is my opinion that the Claim 21 Preamble is also obvious in view of LeFebvre. Specifically, the opinions I have expressed in paragraphs 70–71 above also reflect my opinions with respect to the Claim 21 Preamble, and are incorporated here by reference.

**b. Limitation 21(a): “a. collecting data at periodic intervals about one or more operating parameters of said railcar using one or more sensor units provided on said railcar”**

150. See Limitation 14(a), Section IX.C.2 above, which is incorporated here by reference.

**c. Limitation 21(b): “b. communicating said collected data to a communication management unit”**

151. See Limitation 14(a), Section IX.C.2 above, which is incorporated here by reference. A PHOSITA would understand that LeFebvre’s data control unit is a “communication management unit” in the parlance of the ’673 Patent.

**d. Limitation 21(c): “c. analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data.”**

152. See Limitation 14(b), Section IX.C.12.c above, which is incorporated here by reference.

**e. Claim 21 is obvious over LeFebvre**

153. LeFebvre therefore discloses or renders obvious every element of independent claim 21, in detail, and in the same arrangement as required by the claim. Additionally, it is my opinion that LeFebvre provides an enabling disclosure

of every element of claim 21. LeFebvre’s disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre’s invention (i.e., could have implemented the railcar monitoring system disclosed by LeFebvre) without undue experimentation. To the extent that different elements of claim 21 are described in different portions of LeFebvre’s specification, a PHOSITA would have immediately understood—based upon the disclosure of LeFebvre—that they could be combined in the manner I have described above. It is therefore my opinion that claim 21 is obvious over LeFebvre.

## **19. Dependent Claim 22**

**a. Limitation 22(a): “The method of claim 21 further comprising the steps of: assessing the collected data to determine if an alarm condition exists”**

154.        *See* Limitation 16(a), Section IX.C.14.a above, which is incorporated here by reference.

**b. Limitation 22(b): “wirelessly communicating said alarm condition to an off railcar location.”**

155.        *See* Limitation 16(b), Section IX.C.14.b above, which is incorporated here by reference.

156.        It is therefore my opinion that LeFebvre discloses or renders obvious every element of dependent claim 22.

**D. Ground 2: Claims 8 and 9 are invalid as obvious over LeFebvre in view of Barone.**

157. A PHOSITA would have found it obvious to combine the disclosures of LeFebvre and Barone. Both references describe systems for wirelessly monitoring railcars, and utilize nearly identical components that function in a similar way. Specifically:

**1. Motivation to Combine LeFebvre and Barone**

158. A PHOSITA would have found it obvious to combine the disclosures of LeFebvre and Barone. Both references describe systems for wirelessly monitoring railcars, and utilize nearly identical components that function in a similar way.

159. Like LeFebvre, Barone is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1007, (57) Abstract.

160. Like LeFebvre, Barone utilizes a plurality of sensors to monitor the wheels and wheel bearings on each railcar, wherein the sensors are connected using a wireless mesh network. EX1007, (57) Abstract. In both references, the wireless mesh network preferably conforms to the IEEE 802.15.4 “Zigbee” standard. EX1007, ¶ [0086].

161. Like LeFebvre, Barone also discloses that the collected data is analyzed to determine, for example, if a wheel bearing failure is approaching or imminent. EX1007, ¶¶ [0201]–[0220].

162. Like LeFebvre, Barone discloses that if a failure condition is detected, an alert (including the underlying data) is communicated to the locomotive and/or to a central monitoring station in a remote location. EX1007, ¶ [0045].

163. A PHOSTIA therefore would have understood that LeFebvre and Barone are analogous art. LeFebvre and Barone solve the same problem using the same components in the same way. They are extremely similar references that describe extremely similar systems for monitoring the condition of wheels and wheel bearings on railcars. Because they are both directed to the same subject matter, a PHOSITA would have been motivated to consider the teachings of both references. A PHOSITA also would have understood that because the systems, methods, and devices described in the references are so similar, their teachings could be combined with a reasonable expectation of success.

164. My opinions with respect to particular claims are set forth in more detail below.

## **2. Dependent Claim 8**

### **a. Limitation 8(a): “The method of claim 2 further comprising the steps of: receiving data from a plurality of railcars”**

165. In LeFebvre’s system, each railcar is equipped with a data control unit that transmits data and alarm messages to a remote receiver. *See* Dependent Claim 6, Section IX.C.6 above. The remote receiver may be, for example, a base station located in the locomotive or a central data handling location. EX1005, ¶¶ [0003], [0038], [0052], [0095].

166. LeFebvre therefore discloses a remote receiver—located either in the locomotive or at an off-train location—that receives data from a plurality of data control units (each of which is associated with a different railcar).

### **b. Limitation 8(b): “applying a heuristic to said received data to determine deviations from nominal operating conditions”**

167. LeFebvre describes a wide variety of heuristics that may be applied to collected data by the instrumented pads and/or the data control units. LeFebvre does not expressly disclose that heuristics can be applied to data collected from multiple railcars (e.g., at remote receiver located in the locomotive or a central data handling location).

168. Both LeFebvre and Barone disclose numerous heuristics for analyzing sensor data and detecting severe conditions that may warrant a high level alarm. *See* Limitation 1(b), Section IX.C.1.b above; EX1007, ¶¶ [0037]–[0041]. A PHOSITA would have been motivated to modify LeFebvre’s system by applying

heuristics to sensor data collected at a remote receiver, whether in the locomotive or at a central data handling location, for at least two reasons.

169.       *First*, because each data control unit has access to data from only a single railcar, but the remote receiver collects data from *multiple* railcars, the remote receiver has the ability to detect dangerous conditions that could not be observed by any single data control unit. As an illustrative example: an issue with the braking system on a *single* railcar may be only a minor concern, but a braking issue affecting *multiple* railcars could be catastrophic. This condition could not be observed by any single data control unit, but could be easily observed by a remote receiver with access to data collected from multiple railcars. Another example is recognizing a track defect, such as a broken rail weld combining two sections. One rail car might detect two high acceleration signals on the left side of the tracks that occurred exactly 250 milliseconds apart, but without additional data, this reading would be inconclusive. However, if that data is combined with other cars on the same rail that show similarly spaced, high acceleration signals (and taking the overall speed of the train into account), the existence of a critical issue with the track can be confirmed. It therefore would have been obvious for a PHOSITA to apply heuristics at a remote receiver (i.e., in the locomotive or at a central data handling location) to detect potentially serious issues involving multiple railcars and/or track, and to raise an alarm if any such issues are detected.

170.       *Second*, a remote receiver—whether located in the locomotive, or in a central data handling location—will have access to significantly greater data storage, memory, and processing resources than any unit located on a railcar (e.g., a sensor unit or CMU). For example, a remote receiver located in the locomotive, as described in Barone, has access to both “an abundance of electrical power” and “the existing locomotive computer processor” (EX1007, ¶¶ [0087], [0088], [0269]). Likewise, by the filing date of the ’673 Patent, the benefits of analyzing data collected at a central location had become well-known in the industry. For example, Azzaro recognized—as early as 2000—that “[w]ith today's advances in computing technology, the large amount of data collected from a fleet of locomotives can be properly aggregated and analyzed.” EX1010, 2:24–34. A PHOSITA would therefore understand that, compared to a data control unit or a sensor node, a remote receiver has the ability to conduct more computationally intensive types of heuristics.

171.       For example, Barone discloses that its system “monitors bearing temperature, bearing vibration, bearing acoustic signature, wheel impact load, and car hunting and reports critical situations back to the central monitoring station, thus allowing continuous monitoring and true trending data analysis.” EX1007, ¶ [0045] (emphasis added). “Trending analysis” is a type of heuristic that has been “widely acclaimed” for the “vastly improved failure prediction capability” that it

provides. EX1007, ¶ [0042]. Barone performs “trending analysis” on data aggregated from multiple railcars at its central monitoring station, and it would have been obvious to implement this type of analysis in LeFebvre’s system as well.

172. For all of these reasons, a PHOSITA would have been motivated to apply heuristics to the data aggregated at LeFebvre’s remote receiver (i.e., data collected from multiple railcars), in order to detect conditions that are impractical or impossible to detect at the data control unit, which has access to data from only a single railcar.

**c. Limitations 8(c) and 8(d): “assigning a severity level to said deviations from nominal operating conditions [and] determining an alarm condition based on said assigned severity level”**

173. As discussed above, LeFebvre’s system distinguishes between (a) deviations from expected operating conditions that *are not* severe enough to raise an alarm; and (b) deviations that *are* severe enough to raise an alarm. *See* Limitation 1(c), Section IX.C.1.d above, which is incorporated here by reference. Alarm messages are generated only when the detected deviation is severe enough to warrant an alarm. *See* Limitation 1(d), Section IX.C.1.e above, which is incorporated here by reference.

174. For the same reasons discussed in LeFebvre and summarized above, it would have been obvious for a PHOSITA to apply these same principles when

analyzing data aggregated from multiple CMUs (e.g., at a remote receiver located in the locomotive).

**d. Limitation 8(e): “transmitting said raised alarm to a display unit on a train of which said plurality of railcars are a part.”**

175. LeFebvre discloses a remote receiver in the locomotive that displays alarm conditions raised by the data control unit. LeFebvre’s Claim 23, for example, is directed to “a receiver located in the locomotive for communication of said signals to crew members located within the locomotive.” EX1005, Claim 23. *See also* EX1005, ¶ [0095].

176. More generally, LeFebvre teaches that alarm messages regarding severe conditions, such as wheel or bearing failure, should be communicated to the locomotive as quickly as possible—in time for the locomotive operators to take action to stop the train and prevent further (potentially catastrophic) damage. EX1005, ¶¶ [0003], [0052], [0061] (“Identifying when a wheel set has derailed prevents a possible full derailment and possible catastrophic consequences.”). *See also* EX1005, ¶ [0095].

177. Barone’s system also includes a remote receiver in the locomotive. EX1007, ¶¶ [0087]–[0089]. The remote receiver processes data from the sensor nodes “and displays reports of the data to users in the locomotive itself.” *Id.*, ¶ [0089]. It has the ability to raise “an audible alarm” to alert the locomotive operators of “especially urgent conditions.” *Id.*, ¶¶ [0088], [0089]. To whatever

extent this limitation is not expressly disclosed by LeFebvre, a PHOSITA would have been motivated to include a base unit in the locomotive that displays data and alarm messages to alert locomotive operators of “especially urgent conditions” as disclosed in Barone.

178. In my opinion, a PHOSITA could have arrived at the solution of claim 8 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of LeFebvre, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that LeFebvre, in view of Barone and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 8.

### **3. Dependent Claim 9**

#### **a. Limitation 9(a): “The method of claim 6 further comprising the steps of a. determining a recommended course of action based on said alarm condition”**

179. LeFebvre does not expressly state that its alarm message includes a “recommended course of action.”

180. A PHOSITA, however, would understand that the *entire purpose* of LeFebvre’s system is to identify railcar components in need of repair or replacement, thereby providing an opportunity to take corrective action before a catastrophic failure occurs. *See* EX1005, ¶ [0059] (“Identifying a failing bearing in

its early stages is important in preventative maintenance programs.”); *id.*, ¶ [0060] (“Monitoring wheel impacts may allow an owner to schedule a wheel change out before it is identified by a trackside Wheel Impact Load Detector resulting in unscheduled maintenance.”); *id.*, ¶ [0061] (“Identifying when a wheel set has derailed prevents a possible full derailment and possible catastrophic consequences.”); *id.*, ¶ [0064] (“This provides information about what caused the displacement as well as drawing attention to an urgent maintenance need to avoid damage to the roller bearing.”)

181. A PHOSITA would have understood that in the context of a railcar monitoring and alarm system, indicating the recommended action that should be taken in response to an alarm is a conventional, obvious feature that provides clear advantages. For example, Barone states that “[t]he locomotive computer system, responsive to that data then generates an appropriate alarm or indication to prompt a human user to take remedial action.” EX1007, ¶ [0191]. See *also* EX1007, ¶ [0036] (“If the estimated time to bearing failure permits, a maintenance action can be scheduled. If failure is estimated to be imminent, the train can be diverted or stopped before catastrophic bearing failure and derailment.”). To whatever extent this limitation is not expressly disclosed by LeFebvre, a PHOSITA would have been motivated to modify LeFebvre’s alarm messages to “prompt a human user to take remedial action” as disclosed in Barone.

**b. Limitation 9(b): “b. transmitting said recommended course of action to a display unit on a train of which said railcar is a part.”**

182. See Limitation 8(e), Section IX.D.2.d above, which is incorporated here by reference.

183. In my opinion, a PHOSITA could have arrived at the solution of claim 9 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of LeFebvre, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that LeFebvre, in view of Barone and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 9.

**E. Ground 3: Claims 1, 2, 4, 6–11, and 13 are invalid as obvious over Armitage.**

184. In my opinion, Armitage—as it would have been understood by a PHOSITA—discloses each and every limitation of claims 1–7, 10–18, and 20–22. The claims therefore would have been obvious to a PHOSITA.

185. Armitage’s entire disclosure is directed to a railcar monitoring system. To the extent that Armitage can be viewed as disclosing different embodiments of a railcar monitoring system, those embodiments are very similar to one another, and share most if not all of the features recited by claims 1–7, 10–18, and 20–22. In my opinion, a PHOSITA could have, and would have, combined the teachings of

Armitage as set forth in detail below. It is also my opinion that a PHOSITA could have combined the teachings of Armitage as discussed below with a reasonable expectation of success.

186. It is also my opinion that Armitage provides an enabling disclosure of every element of these claims. Armitage's disclosure is sufficiently detailed that a PHOSITA could have practiced Armitage's invention (i.e., could have implemented the railcar monitoring systems and sensing/monitoring devices disclosed by Armitage) without undue experimentation. A PHOSITA could have followed the teachings of Armitage to arrive at the claimed systems and devices with a reasonable expectation of success.

187. More generally, the elements of claims 1–7, 10–18, and 20–22 are all well-known in the art, and would have been fully understood by a PHOSITA. The art to which these claims are directed—systems and sensors for monitoring operational parameters of railcars—is predictable, involving simple mechanical components and widely available, off-the-shelf electronic components. The recited method steps (collecting data from sensors, applying heuristics to detect deviations from normal operating conditions, using a wireless network to transmit an alarm message, etc.) have been known and used in the prior art for decades, as I explained above in Section V, paragraphs 29–41, which are incorporated here by reference. For at least these reasons, it is my opinion that a PHOSITA could have

made any required adjustments or modifications to Armitage's disclosed systems and sensors with a reasonable expectation of success and without undue experimentation.

## **1. Independent Claim 1**

### **a. Claim 1 Preamble: "A method of monitoring operational characteristics of a railcar comprising the steps of:"**

188. I have been informed by counsel that claim preambles are generally not limiting when the content of the claimed preamble is an "intended use." I have been informed by counsel that preambles are generally statements of intended use when the body of a claim fully sets forth all the limitations of the claimed invention, and the preamble merely states the purpose or intended use of the invention. Here the preamble merely states "[a] method of monitoring operational characteristics of a railcar." In my opinion, this preamble is entirely a statement of intended use, and so should not be given patentable weight.

189. Even so, if the preamble was limiting, Armitage discloses the entire preamble. Specifically, Armitage discloses "a mobile railway car monitoring system" that includes "a plurality of sensor nodes ... configured to monitor the undercarriage portion of the railway car." EX1006, 57 (Abstract). The sensor nodes comprise, for example, temperature sensors. EX1006, ¶ [0014].

190. I also feel the need to point out that the design of Armitage's system is extremely similar to that of the '673 Patent. Compare Figure 1 of Armitage:

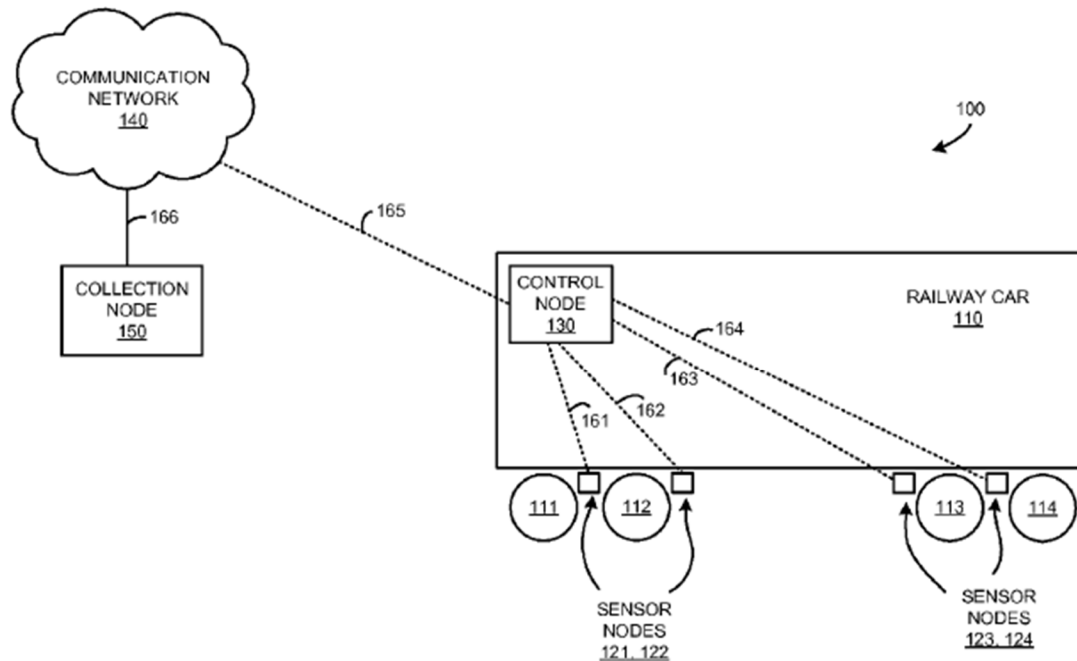


**FIGURE 1**

with Figure 6 of the '673 Patent, which I have reproduced below.

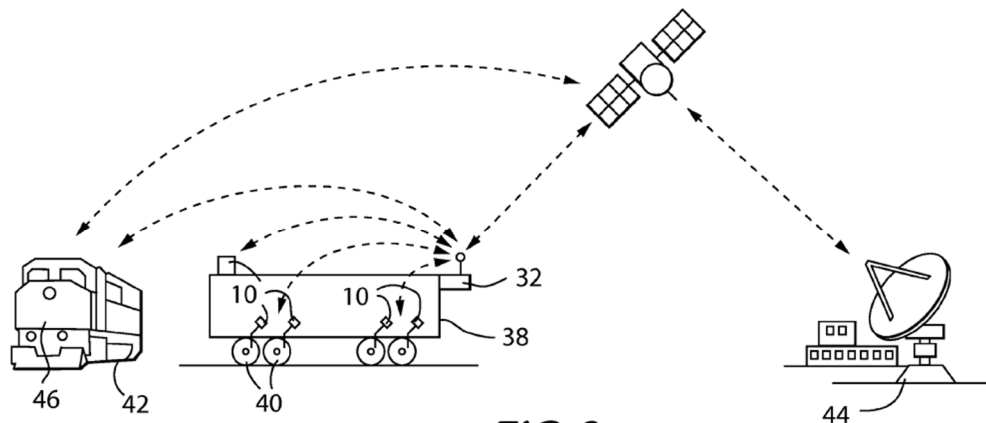


**FIG.6**

**b. Limitation 1(a): “a. receiving data or processed information regarding said operational characteristic from one or more sensing units on said railcar, said sensing units monitoring an operational characteristic of said railcar”**

191. Armitage discloses a “mobile railway car monitoring system . . .

[including] a plurality of sensor nodes coupled to an undercarriage portion of a

railway car.” EX1006, ¶ [0004]. Figure 1 of Armitage depicts an exemplary embodiment, with four sensor nodes 121–124 attached to a railcar 110. EX1006, ¶ [0012], Fig. 1.

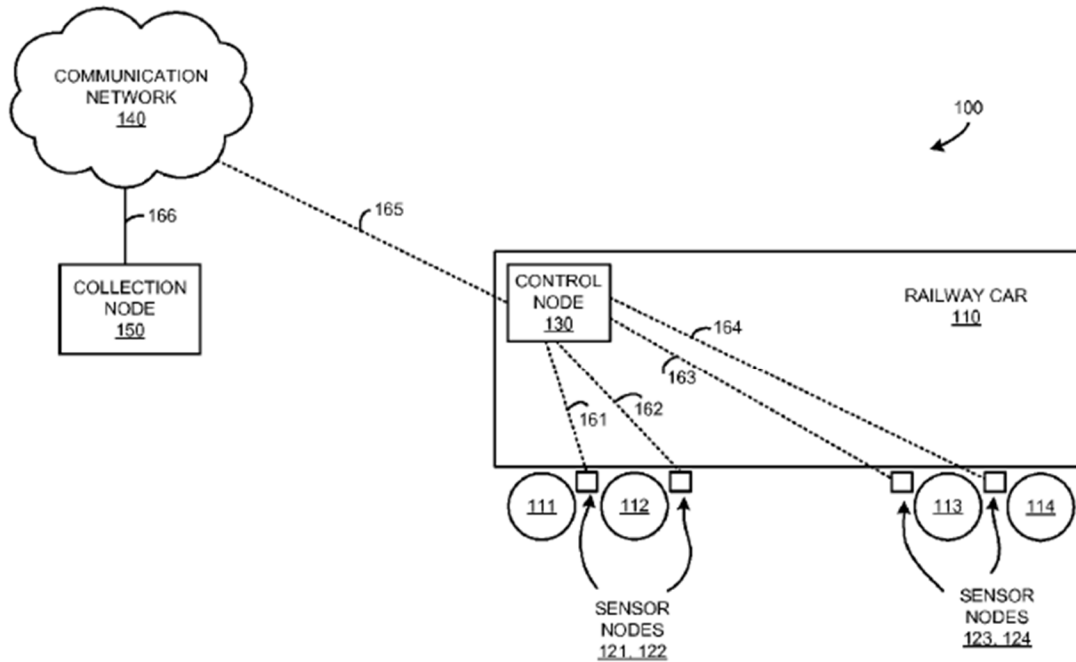


**FIGURE 1**

192. The sensor nodes are separate from one another, and each node is attached to a separate undercarriage element of the railcar. In the exemplary embodiment of Figure 1, “sensor node 121 is coupled to undercarriage element 111, sensor node 122 is coupled to undercarriage element 112, sensor node 123 is coupled to undercarriage element 113, and sensor node 124 is coupled to undercarriage element 114.” EX1006, ¶ [0012]. “Sensor nodes 121-124 each include equipment to sense and report information about undercarriage elements of

a railway car.” EX1006, ¶ [0014]. Each sensor node “includes a sensor portion” that “could include thermometers” or “other sensing equipment and circuitry.” *Id.*

193. Figure 3 of Armitage depicts an exemplary embodiment similar to that of Figure 1, but with ***eight*** sensor nodes 320–327 attached to a railcar 310—specifically, one node attached to each wheel assembly. EX1006, ¶¶ [0033]–[0034], Fig. 3. Sensor nodes 320–327 have the same features described above for nodes 121–124. EX1006, ¶ [0033].

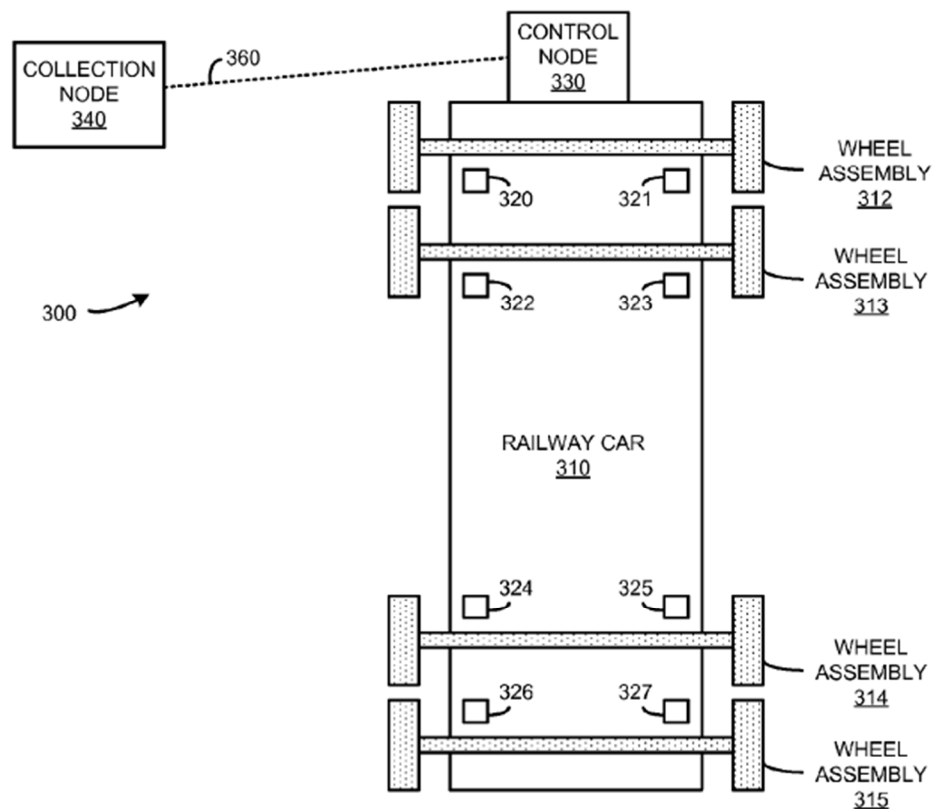


**FIGURE 3**

194. Other than the number of sensor nodes and their precise locations, the embodiments depicted in Figures 1 and 3 of Armitage are largely identical. A

PHOSITA would have understood that features described with reference to an element of Figure 1 are also applicable to the corresponding element of Figure 3, and *vice versa*. *Id.* See EX1006, ¶ [0059].

195. Armitage’s system also includes a “control node” on each railcar. EX1006, ¶¶ [0004], [0012], Figs. 1, 3, 5. The control node receives “sensor information, or modified sensor information” collected by each of the sensor nodes on the same railcar. EX1006, ¶ [0027]. The sensor nodes and the control node communicate over a wireless network. EX1006, ¶¶ [0014], [0033], [0054]. For example, in the embodiment of Figure 1, control node 130 communicates with each of sensor nodes 121–124 via wireless links 161–164, respectively.

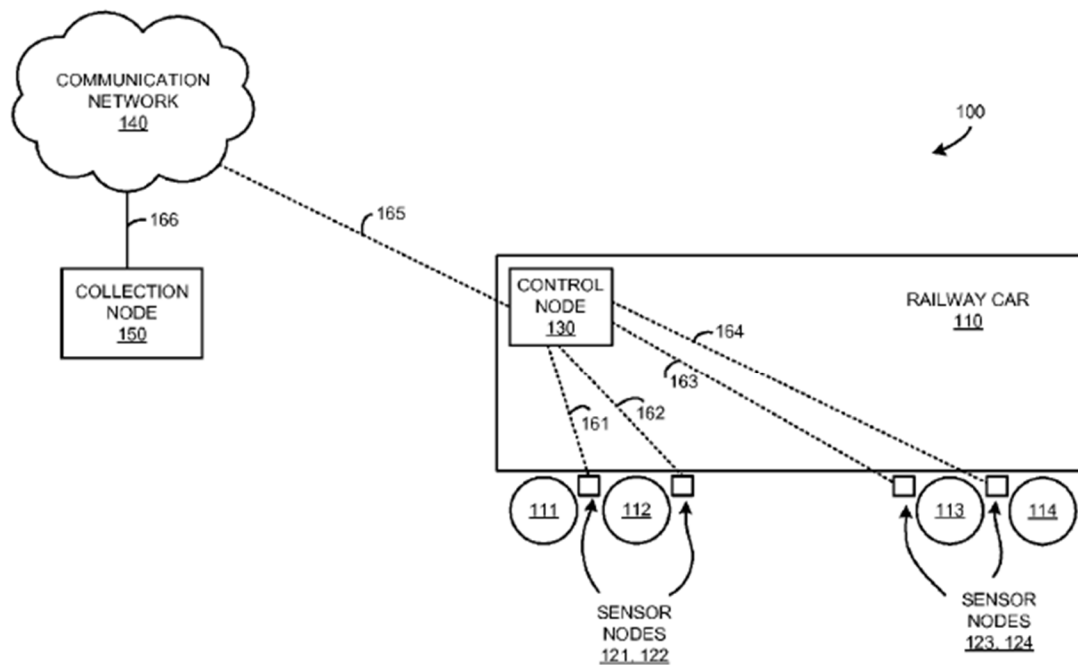


**FIGURE 1**

196. The wireless links can utilize, for example, WiFi or Bluetooth, both of which provide two-way communications. EX1006, ¶ [0021].

197. A PHOSITA would therefore understand that in Armitage's system, the control node on each railcar receives both data and processed information from one or more sensor nodes located on the same railcar.

**c. Limitation 1(b): “b. applying a heuristic to said received data to determine deviations from nominal operating conditions”**

198. After receiving data from the sensor nodes, Armitage's control node analyzes the collected data and uses heuristics to determine whether a fault condition is present. *See* EX1006, ¶ [0027] (“Control node 130 processes (204) the information to determine a fault condition for the undercarriage portion.”). This process is illustrated in Figure 2 of Armitage, which I have reproduced below.

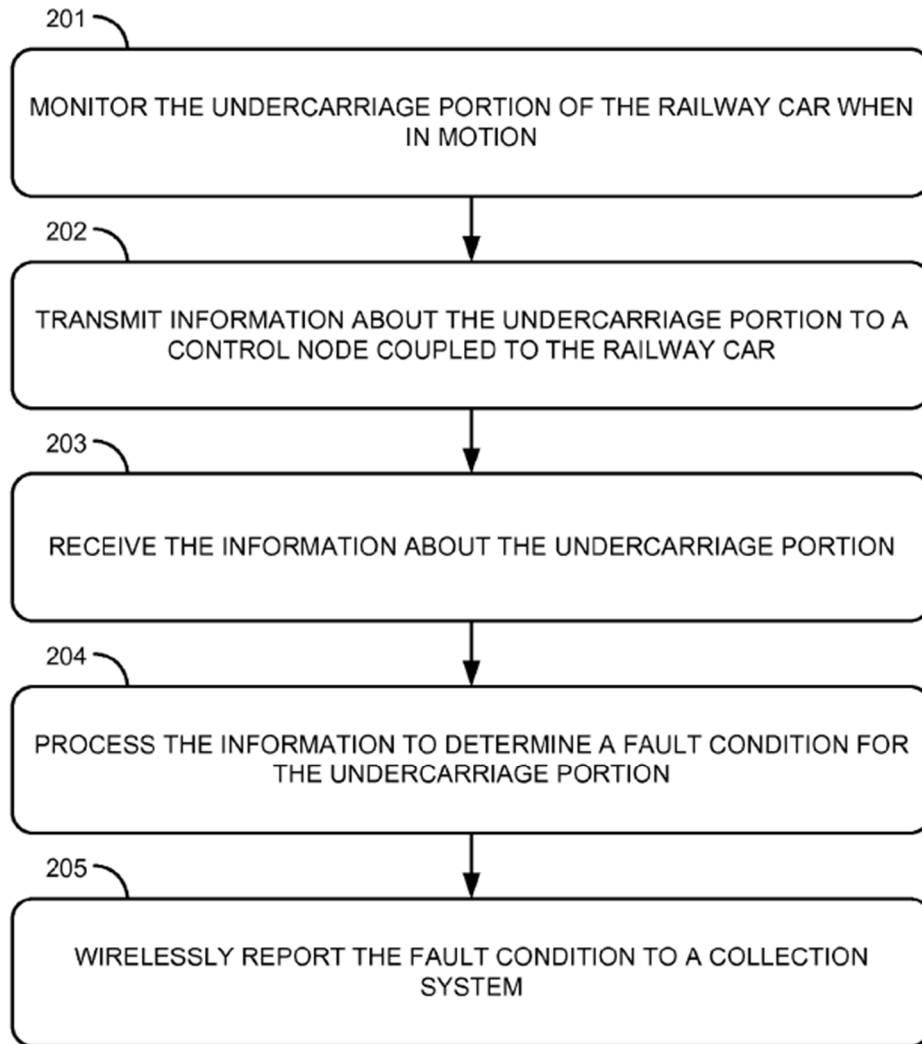


**FIGURE 2**

199. Armitage discloses several statistical methods, or “heuristics,” that can be used to process sensor data and identify deviations from nominal operating conditions. For example, Armitage teaches that “a standard deviation metric is employed to determine when data from one or more sensor nodes becomes an outlier from a main cluster of sensor node data, such as when data from a sensor node deviates by more than three standard deviations[.]” EX1006, ¶ [0041].

Armitage also discloses that “trend modeling” can be used to “identif[y] specific sensor telemetry that lies outside norms, where 'normal' can be defined dynamically by assessing the set of sensors on each railway car.” EX1006, ¶ [0044]. Armitage also provides specific examples of heuristics associated with particular railcar components. For example, Armitage teaches that “[a] single wheel sensor anomaly might ... indicate a 'wheel out of round' or 'flat spot' condition, where a non-round geometry of a wheel can cause vibrations or shocks at a certain portion of each rotation of a wheel.” EX1006, ¶ [0042]. Conversely, “outliers for sensor nodes on an entire side of railway car 310 could indicate a cornering failure, or an off-track condition.” *Id.*

**d. Limitations 1(c) and 1(d): “c. assigning a severity level to said deviations from nominal operating conditions [and] d. determining an alarm condition based on said assigned severity level.”**

200. Armitage recognizes that only “significant” deviations from nominal operating conditions—and not *all* detected deviations—should cause an alarm message (or “event”) to be generated. EX1006, ¶ [0043].

201. Armitage’s system includes a “railway car health scorecard” that distinguishes between potential failures (which warrant maintenance) and actual failures (which require immediate service):

“Each event could be ranked by severity and status could be provided periodically, such as twice daily, to provide

railcar location and system status. The event ranking could include a ‘yellow’ condition which indicates that a railway car requires service, and a ‘red’ condition which indicates that a sensor has detected a serious deviation from normal operations that requires immediate service.”

EX1006, ¶ [0044]. This analysis is carried out by Armitage’s “Data Correlation Unit (DCU).” EX1006, ¶ [0043]. The DCU can comprise the control node (e.g., control node 130) and/or the collection node (e.g., collection node 150). *Id.* The DCU generates an alarm only “when a sensor exhibits ‘**significant**’ deviation from the normal conditions.” EX1006, ¶ [0043] (emphasis added).

202. A PHOSITA would therefore understand that Armitage’s system assigns a severity level to detected deviations from nominal operating conditions, and generates alarms (e.g., “yellow” or “red” alarms) based on the assigned severity level.

**e. Claim 1 is obvious over Armitage**

203. Armitage therefore discloses or renders obvious every element of independent claim 1, in detail, and in the same arrangement as required by the claim. Additionally, it is my opinion that Armitage provides an enabling disclosure of every element of claim 1. Armitage’s disclosure is sufficiently detailed that a PHOSITA could have practiced Armitage’s invention (i.e., could have implemented

the railcar monitoring system disclosed by Armitage) without undue experimentation. To the extent that different elements of claim 1 are described in different portions of Armitage's specification, a PHOSITA would have immediately understood—based upon the disclosure of Armitage—that they could be combined in the manner I have described above. It is therefore my opinion that claim 1 is obvious over Armitage.

**2. Dependent Claim 2: “d. determining an alarm condition based on said assigned severity level.”**

204. See Limitation 1(a), Section IX.E.1.b above. For the same reasons I have discussed above with respect to Limitation 1(a), it is also my opinion that each limitation of Dependent Claim 2 is obvious in view of Armitage. Specifically, the opinions I have expressed in paragraphs 191–197 above also reflect my opinions with respect to Dependent Claim 2, and are incorporated here by reference.

**3. Dependent Claim 4: “The method of claim 2 wherein steps a-d are executed by a processing unit located on said railcar.”**

205. As I have explained in detail above with respect to Independent Claim 1, in Armitage's system each step (a)–(d) of claim 1 can be carried out by a control node located on the railcar. See Limitations 1(a)–1(d), discussed in Sections IX.E.1.b, IX.E.1.c, and IX.E.1.d above, each of which is incorporated here by reference.

206. As discussed above, step (a) is carried out by the control node (e.g., control node 150) attached to the railcar. *See* Armitage, ¶ [0026] (“Each of sensor nodes 121-124 transmits (202) the monitored information about the undercarriage portion to control node 130 coupled to railway car 110.”). *See also* Section IX.E.1.b above.

207. As discussed above, step (b) is also carried out by the control node. *See* Armitage, ¶ [0027] (“Control node 130 processes (204) the information to determine a fault condition for the undercarriage portion.”). *See also* Section IX.E.1.c above.

208. And as discussed above, steps (c) and (d) are carried out by Armitage’s “Data Correlation Unit (DCU)”, which is “installed on each railway car” and can comprise the control node (e.g., control node 130). EX1006, ¶¶ [0043], [0044]. *See also* Section IX.E.1.d above.

209. It is therefore my opinion that Armitage discloses or renders obvious every element of claim 4.

**4. Dependent Claim 6: “The method of claim 2 further comprising the step of transmitting said alarm condition to a location remote from said railcar.”**

210. In Armitage’s system, if the control node detects a fault condition, it wirelessly reports the fault (i.e., sends an alarm message) to a collection system. EX1006, ¶ [0028]. *See*, for example, step 205 in Figure 2 of Armitage:

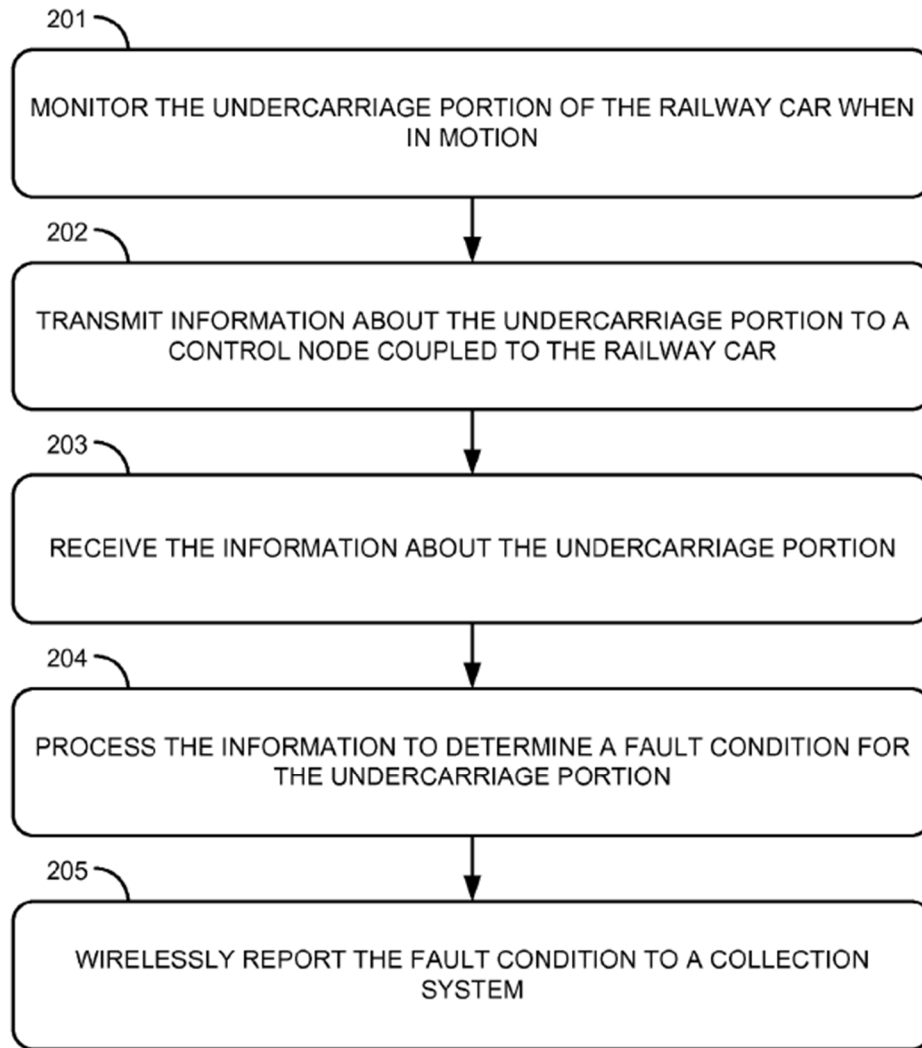


**FIGURE 2**

211. Armitage discloses that the collection system comprises a “collection node” located off the train. For example, the collection node can be “a rail-side or handheld device.” EX1006, ¶ [0039]. Alternatively, the collection node can comprise “application servers,” “web servers,” and other computing equipment. EX1006, ¶¶ [0019], [0039]. A PHOSITA would understand that “rail side” devices, “web servers,” and “application servers” would not be located on the train.

212. Armitage therefore discloses wirelessly reporting alarm conditions to a “collection system” that is located off the train, as required by dependent claim 6.

**5. Dependent Claim 7: “The method of claim 2 further comprising the step of transmitting said data received from said one or more sensing units to a location remote from said railcar.”**

213. Armitage discloses that the control node transmits data—specifically, data collected from the sensors—to the collection node. Specifically, Armitage discloses that “[c]ollection node 150 comprises equipment for receiving fault conditions, sensor information, location information, or other information from control node 130.” EX1006, ¶ [0019].

214. Armitage also discloses that the collection node is located off the train. *See* Dependent Claim 6, Section IX.E.4 above, which is incorporated here by reference.

215. It is therefore my opinion that Armitage discloses or renders obvious every element of dependent claim 7.

**6. Dependent Claim 8**

**a. Limitation 8(a): “The method of claim 2 further comprising the steps of: receiving data from a plurality of railcars”**

216. As I have explained above, Armitage’s system includes one “control node” on each railcar. *See* Limitation 1(a), Section IX.E.1.b above, which is incorporated here by reference. Armitage’s collection system receives data from multiple control nodes—and, therefore, from multiple railcars:

“Collection node 150 could collect fault conditions and other information from many control nodes. For example, on a train where many railway cars are connected in series, a control node could be coupled to each railway car along with associated sensor nodes. Collection node 150 could receive information from each control node of the train, and thus monitor the entire train.”

EX1006, ¶ [0020].

**b. Limitation 8(b): “applying a heuristic to said received data to determine deviations from nominal operating conditions”**

217. Armitage discloses that data collected from the sensors is analyzed by the Data Correlation Unit (DCU), which can comprise the collection system (e.g., collection node 150). EX1006, ¶¶ [0043], [0044].

218. Armitage teaches that the collection node can apply heuristics to data aggregated from multiple control units and railcars. Specifically, by analyzing the data aggregated by the collection node, “[f]ault conditions could be isolated to a particular railway car, or to a specific location, which may detect track failure or be used to assess root cause of the failure.” EX1006, ¶ [0038].

219. As I have discussed above, Armitage also describes numerous heuristics that are used to analyze data collected from its sensors. *See* Limitation 1(b), Section IX.E.1.c above, which is incorporated here by reference. To the

extent Armitage does not expressly state that each of these heuristics is applied to data collected from multiple railcars (as opposed to data collected from only a single railcar), a PHOSITA would have been motivated to apply heuristics to data aggregated at the collection node for the same reasons discussed in Section IX.D.2.b above, which is incorporated here by reference. For example, it would have been obvious to apply a heuristic at the collection node to determine whether *multiple* railcars are simultaneously experiencing a braking failure, which would be an extraordinarily dangerous situation that could not be detected by any single control unit. *See* Section IX.D.2.b above.

**c. Limitations 8(c) and 8(d): “assigning a severity level to said deviations from nominal operating conditions [and] determining an alarm condition based on said assigned severity level”**

220. As discussed above, Armitage’s system assigns a severity level to detected deviations from nominal operating conditions, and generates alarms (e.g., “yellow” or “red” alarms) based on the assigned severity level. *See* Limitation 1(c), Section IX.C.1.d above, which is incorporated here by reference.

**d. Limitation 8(e): “transmitting said raised alarm to a display unit on a train of which said plurality of railcars are a part.”**

221. Armitage teaches that “[a] railway car health 'scorecard' could be provided to a user, presented via email, text message, web page, or discrete software interfaces.” EX1006, ¶ [0044]; *see also* Limitation 1(c), Section IX.C.1.d

above, which is incorporated here by reference. A PHOSITA would have understood that the scorecard is displayed to operators in the locomotive.

222. To the extent that Armitage does not expressly state that the alarms are displayed to a user on the train, a PHOSITA would have been motivated to modify Armitage's system to include a device that displays alerts to the operators in a locomotive. For example, an alarm message indicating "a cornering failure, or an off-track condition" affecting one or more railcars (*see* EX1006, ¶ [0042]) would be of great interest to the locomotive operator—who could then take action to stop the train and prevent further (potentially catastrophic) damage.

223. It is therefore my opinion that Armitage discloses or renders obvious every element of claim 8.

## **7. Dependent Claim 9**

**a. Limitation 9(a): "The method of claim 6 further comprising the steps of a. determining a recommended course of action based on said alarm condition"**

224. Armitage describes a "railway car health scorecard," which recommends a course of action based on the level of the alarm that is raised. *See* Limitation 1(c), Section IX.C.1.d above, which is incorporated here by reference. In Armitage's system, a "yellow" condition "indicates that a railway car requires service," while a "red" condition indicates "a serious deviation from normal operations that requires immediate service." EX1006, ¶ [0044].

**b. Limitation 9(b): “b. transmitting said recommended course of action to a display unit on a train of which said railcar is a part.”**

225. A PHOSITA would understand that Armitage’s “railway car health scorecard” is displayed to operators in the locomotive. *See* Limitation 8(e), Section IX.E.6.d above, which is incorporated here by reference. Alternatively, a PHOSITA would have been motivated to modify Armitage’s system to include a device that displays alerts to the operators in a locomotive for the reasons discussed above in Section IX.E.6.d.

226. It is therefore my opinion that Armitage discloses or renders obvious every element of claim 9.

## **8. Independent Claim 10**

**a. Claim 10 Preamble: “A method of monitoring a temperature of a desired part of a railcar, comprising:”**

227. *See* Claim 1 Preamble, Section IX.E.1.a above. For the same reasons I have discussed above with respect to the Claim 1 Preamble, it is my opinion that the Claim 10 Preamble is also obvious in view of Armitage. Specifically, the opinions I have expressed in paragraphs 188–190 above also reflect my opinions with respect to the Claim 10 Preamble, and are incorporated here by reference.

**b. Limitations 10(a) and 10(b): “(a) sensing the temperature of a part of the railcar other than the desired part by use of a temperature sensor in**

**thermal communication with said other part [and] (b) determining the temperature of the desired part by use of the temperature sensed in step (a)”**

228. Armitage discloses a mobile railway car monitoring system including a plurality of sensor nodes, each of which can comprise one or more temperature sensors. *See* Section IX.E.1.a above.

229. The temperature sensors can be used to monitor wheel bearing temperature. EX1006, ¶ [0027]. Armitage does not state that the temperature sensors are attached directly to the wheel bearing. To the contrary, Armitage teaches that its sensors are preferably attached to non-rotating elements, such as brackets or bearing mounts. EX1006, ¶ [0034] (“Sensor nodes 320-327 are each attached or coupled to the associated wheel assembly, preferably to a non-rotating portion, such as a bracket, bearing mount, or other nonrotating structure.”).

230. As I have explained in detail in Section IX.C.8.b above, which is incorporated here by reference, a PHOSITA would understand that direct attachment to a wheel bearing is typically impractical because a wheel bearing is a moving component. In my experience, directly attaching a temperature sensor to a rotating bearing is usually impractical. While not impossible, it is more difficult and expensive to attach sensors to moving components, and especially components such as bearings that can spin rapidly. In my experience, it is much more common to indirectly measure the temperature of a rotating mechanical component (e.g., a wheel bearing) by attaching a temperature sensor to a nearby, stationary component

that is in thermal communication with the rotating component. This arrangement has been commonplace in industry for decades, and would be familiar to any PHOSITA.

231. For example, US 2005/0194497 to Matzan (“Matzan”) discloses a system “for automatic detection of overheated wheel bearings of railroad cars and carriages.” EX1018, (57) Abstract. Matzan teaches that “[s]ignals representing the temperature of such bearings are generated by temperature sensors that are *installed in close proximity of the wheel bearings.*” *Id.* Matzan merely provides confirmation and support for my opinion that this practice is commonplace in industry and that its advantages would be familiar to any PHOSITA.

232. Accordingly, a PHOSITA who was interested in measuring the temperature of a wheel bearing on a railcar would have been motivated to attach the temperature sensor to a stationary component of the railcar adjacent to the wheel bearing (rather than to the wheel bearing itself). The PHOSITA would have understood that this arrangement is mechanically simple, conventional, and easier to implement than attaching a sensor to the bearing directly.

**c. Limitation 10(c): “(c) determining if said temperature of the desired part is outside an acceptable range of temperatures”**

233. Armitage teaches that the temperature of the wheel bearing should be monitored to determine if it is outside an acceptable range. For example, “[c]ontrol node 130 could process the sensor information to determine anomalies from an

average, such as an anomaly from a running average of the temperature of all wheels on railway car 110.” EX1006, ¶ [0029]. Additionally, as discussed above in Limitation 1(b), Section IX.E.1.c above, which is incorporated here by reference, Armitage discloses numerous heuristics that can be used to process sensor data and determine whether a fault condition (e.g., excessively high bearing temperature) is present.

**d. Limitation 10(d): “(d) transmitting an alarm if in step (c) it is determined that the temperature of the desired part is outside an acceptable range.”**

234. Armitage teaches that an alarm message is generated if a monitored parameter, such as temperature, is outside the expected range and the deviation is significant enough to warrant an alarm. *See* Limitation 1(c), Section IX.C.1.d above, which is incorporated here by reference.

**e. Claim 10 is obvious over Armitage**

235. Armitage therefore discloses or renders obvious every element of independent claim 10, in detail, and in the same arrangement as required by the claim. Additionally, it is my opinion that Armitage provides an enabling disclosure of every element of claim 10. Armitage’s disclosure is sufficiently detailed that a PHOSITA could have practiced Armitage’s invention (i.e., could have implemented the railcar monitoring system disclosed by Armitage) without undue experimentation. To the extent that different elements of claim 10 are described in

different portions of Armitage’s specification, a PHOSITA would have immediately understood—based upon the disclosure of Armitage—that they could be combined in the manner I have described above. It is therefore my opinion that claim 10 is obvious over Armitage.

**9. Dependent Claim 11: “A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, further comprising the step of determining the temperature of the ambient air, which temperature is used in the determination of step (b).”**

236. Armitage discloses that each sensor node may include a sensor for monitoring the ambient air temperature. EX1006, ¶ [0025] (“The information monitored could include ... ambient temperature”); *id.*, ¶ [0029] (“the ambient temperature or weather conditions could be evaluated”).

237. Armitage recognizes that “sensor information can be affected by ambient temperature.” EX1006, ¶ [0029]. This is a basic fact that is part of the general knowledge in the field and would have been well-understood by a PHOSITA.

238. Armitage further states that “the ambient temperature or weather conditions” should be evaluated to determine whether an anomaly is present in an undercarriage element. EX1006, ¶ [0029]. A PHOSITA would therefore understand that, in Armitage’s system, information collected from temperature sensors should be calibrated—taking ambient temperature and weather into account—before reporting a fault condition or raising an alarm.

239. It is therefore my opinion that Armitage discloses or renders obvious every element of dependent claim 11.

**10. Dependent Claim 13: “The method of claim 1 wherein steps (a) through (d) can be carried out at different event engines distributed among at least two of said sensor units, a communication management unit, and a mobile or land base station.”**

240. As described above, in Armitage’s system steps (a) and (b) of claim 1 are carried out by the control node. *See* Dependent Claim 4, Section IX.E.3 above, which is incorporated here by reference. Step (a) is additionally carried out by Armitage’s sensor nodes—each sensor node receives data from its own associated sensors. *See* Limitation 1(a), Section IX.E.1.a above, which is incorporated here by reference.

241. Steps (c) and (d) are carried out by Armitage’s “Data Correlation Unit (DCU).” *See* Limitation 1(c), Section IX.C.1.d above, which is incorporated here by reference. The Data Correlation Unit can comprise the collection node (e.g., collection node 150). EX1006, ¶ [0043].

242. Accordingly, Armitage discloses, or at least renders obvious, an embodiment wherein step (a) is carried out by a plurality of sensor nodes located on a railcar; steps (a) and (b) are carried out by a control node; and steps (c) and (d) are carried out by a collection node, thereby meeting the limitations of claim 13.

**F. Ground 4: Claims 3, 5, 12–18, and 20–22 are invalid as obvious over Armitage in view of LeFebvre.**

**1. Motivation to Combine Armitage and LeFebvre**

243. A PHOSITA would have found it obvious to combine the disclosures of Armitage and LeFebvre. The references describe very similar systems for monitoring railcars, which contain nearly identical components that function in a similar way.

244. Like Armitage, LeFebvre is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1005, (57) Abstract.

245. Like Armitage, LeFebvre utilizes a plurality of sensors to monitor the wheels and wheel bearings on each railcar, wherein the sensors communicate wirelessly with a control unit located on the railcar. EX1005, (57) Abstract.

246. Like Armitage, LeFebvre also discloses that the collected data is analyzed to determine, for example, if a wheel bearing failure is approaching or imminent. EX1005, ¶¶ [0058]–[0059].

247. Like Armitage, LeFebvre discloses that if a failure condition is detected, an alert (including the underlying data) is wirelessly transmitted to a data processing system in a remote location. EX1005, ¶¶ [0038], [0052].

248. A PHOSTIA therefore would have understood that Armitage and LeFebvre are analogous art—indeed, they are extremely similar references that

describe extremely similar systems for monitoring the condition of wheels and wheel bearings on railcars. Because the references are so similar, a PHOSITA would have considered both of them when designing and implementing a railcar monitoring system. And in my opinion, a PHOSITA could have combined the teachings found in the disclosures of Armitage and LeFebvre with a reasonable expectation of success.

249. My opinions with respect to particular claims are set forth in more detail below.

**2. Dependent Claim 3: “The method of claim 2 wherein said one or more remote sensing units form a mesh network.”**

250. Armitage does not expressly disclose that one or more remote sensing units form a mesh network. A PHOSITA would understand that a “mesh network” is a networking configuration where each device communicates with two or more other devices.

251. LeFebvre discloses that its sensor nodes may be connected to the CMU using a mesh networking protocol. *See* Section IX.C.2 above, which is incorporated here by reference. A PHOSITA would have understood that mesh networking provides certain advantages relative to point-to-point protocols such as Bluetooth or WiFi. Most significantly, a mesh network allows sensor nodes to be placed in locations where they could not communicate with the CMU directly (e.g., due to interference). *See* Section IX.C.2 above. For at least this reason, a PHOSITA

would have been motivated to modify Armitage to use a wireless mesh network to connect the sensor devices and the control node, as disclosed by LeFebvre. *See* Section IX.C.2 above.

252. In my opinion, a PHOSITA could have arrived at the solution of claim 3 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of Armitage, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 3.

**3. Dependent Claim 5: “The method of claim 4 wherein said processing unit located on said railcar is a part of said mesh network.”**

253. *See* Dependent Claim 3, Section IX.F.2 above. For the same reasons I have discussed above with respect to Dependent Claim 3, it is also my opinion that each limitation of Dependent Claim 5 is obvious in view of Armitage. Specifically, the opinions I have expressed in paragraphs 250–252 above also reflect my opinions with respect to Dependent Claim 5, and are incorporated here by reference.

**4. Dependent Claim 12: “A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, wherein steps (a) through (d) are carried out by a single unit attached to said railcar.”**

254. In my opinion, it would have been obvious to modify Armitage’s system such that each step (a)–(d) of claim 10 is carried out by a single sensor node.

255. As I have explained above, Limitations 10(a) and 10(b) are carried out by Armitage’s sensor node. *See* Limitations 10(a) and 10(b), Section IX.E.8.b above, which is incorporated here by reference.

256. Armitage does not expressly state that its sensor devices “determine[e] if said temperature of the desired part is outside an acceptable range,” as required by Limitation 10(c), or transmit an alarm as required by Limitation 10(d). LeFebvre, however, describes these limitations in detail. *See* Section IX.C.10, paragraphs 115–119 above, which is incorporated here by reference. *See also* Sections IX.C.8.c and IX.C.8.d above, which are also incorporated here by reference.

257. LeFebvre teaches that the burden of transmitting all data collected from the sensors is “extremely large.” EX1005, ¶ [0053]. Specifically, LeFebvre teaches that to “reduce the radio traffic to manageable proportions,” it is desirable to have the sensor devices “[look] for signs of trouble and then send only essential indicative information” upstream to the control node. EX1005, ¶ [0053]. A

PHOSITA would therefore understand that LeFebvre's sensor devices monitor the sensor readings (i.e., temperature) for values outside the expected range, and transmit an alarm upstream (i.e., to the control node) *only* if a deviation from nominal operating conditions is detected.

258. I believe a PHOSITA would have been motivated to modify Armitage's sensor devices to monitor sensor data, determine alarm conditions, and wirelessly transmit any alarms to the data control unit, as disclosed by LeFebvre. This modification would have had an obvious and predictable benefit—specifically, it would reduce the amount of data, and radio traffic, that must be transmitted from the sensor devices to the control unit on each railcar.

259. In my opinion, a PHOSITA could have arrived at the solution of claim 12 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of Armitage, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 12.

**5. Dependent Claim 13: “The method of claim 1 wherein steps (a) through (d) can be carried out at different event engines distributed among at least two**

**of said sensor units, a communication management unit, and a mobile or land base station.”**

260. As I have explained above with respect to Dependent Claim 12, Section IX.F.4 above, a PHOSITA would have been motivated to modify Armitage’s sensor devices to monitor sensor data, determine alarm conditions, and wirelessly transmit any alarms to the data control unit, as disclosed by LeFebvre. Accordingly, the combination of Armitage and LeFebvre discloses, or at least renders obvious, an embodiment wherein each of steps (a)–(d) are carried out by a plurality of sensor devices; steps (a) and (b) are carried out by a control node; and steps (c) and (d) are carried out by a collection node, thereby meeting the limitations of claim 13.

## **6. Independent Claim 14**

**a. Claim 14 Preamble: “A method for monitoring the operation of a railcar performed by a communication management unit disposed on said railcar comprising the steps of:”**

261. See the Claim 1 Preamble, Section IX.E.1.a above. For the same reasons I have discussed above with respect to the Claim 1 Preamble, it is my opinion that the Claim 14 Preamble is also obvious in view of Armitage. Specifically, the opinions I have expressed in paragraphs 188–190 above also reflect my opinions with respect to the Claim 14 Preamble, and are incorporated here by reference. A PHOSITA would additionally understand that Armitage’s

control node is a “central management unit” that performs each step required by claim 14, as explained in detail below.

**b. Limitation 14(a): “a. wirelessly receiving data from one or more sensing units which periodically collect readings from one or more sensors disposed on said railcar”**

262. Armitage’s control node communicates wirelessly with one or more sensor units located on the same railcar. *See* Limitation 1(a), Section IX.E.1.b above, which is incorporated here by reference.

263. Armitage does not expressly disclose that its sensor nodes *periodically* collect sensor readings from the sensor units. In my opinion, this feature would necessarily be present if Armitage’s sensor nodes were equipped with digital sensors. Digital sensors transmit data on a periodic basis (as opposed to analog sensors, which transmit data continuously). Digital sensors are commonplace in the industry and have been in widespread use for decades. It would have been obvious for a PHOSITA to have equipped Armitage’s sensor node with, for example, a digital temperature sensor.

264. This feature is also disclosed, in detail, by LeFebvre. *See* Section IX.C.2 above, paragraphs 124–127 above, which is incorporated here by reference. More generally, the power-saving scheme described by LeFebvre (where an electronic device enters a sleep mode to save power, and awakens periodically to collect data, perform computations, and transmit data over a network) was a well-

known, standard practice prior to the priority date of the '673 Patent. A PHOSITA would have incorporated this well-known feature into Armitage's sensor nodes because—as LeFebvre explains—it predictably saves power. EX1005, ¶¶ [0034]–[0035].

**c. Limitation 14(b): “b. heuristically analyzing said received data to determine if an actual failure exists on said railcar or to predict potential or imminent failures based on a statistical analysis of said received data”**

265. Armitage discloses statistical methods that can be used to process sensor data and detect a deviation from nominal operating conditions. *See* Limitation 1(b), Section IX.E.1.c above, which is incorporated here by reference.

266. Armitage also indicates that its system can distinguish between potential failures (which indicate a need for upcoming maintenance) and actual failures (which require immediate service). *See* Limitation 1(c), Section IX.E.1.d above; Limitation 8(e), Section IX.E.6.d above; and Limitation 9(a), Section IX.E.7.a above; all of which are incorporated here by reference.

**d. Limitation 14(c): “c. communicating the results of said analysis to an off-railcar location.”**

267. *See* Dependent Claim 6, Section IX.E.4 above, which is incorporated here by reference.

**e. Claim 14 is Obvious in view of Armitage and LeFebvre**

268. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every

element of independent claim 14. As I have explained in detail above, a PHOSITA could have arrived at the solution of independent claim 14 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of Armitage, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that claim 14 is obvious over Armitage in view of LeFebvre.

## **7. Dependent Claim 15**

**a. Limitation 15(a): “The method of claim 14 wherein each of said sensing units can make a determination of an alarm condition based on data collected by the sensing unit, said method further comprising the step of: a. wirelessly receiving notice of said alarm condition from said sensing unit”**

269. As explained above, it would have been obvious to modify Armitage’s sensor devices to monitor sensor data, determine alarm conditions, and wirelessly transmit any alarms to the control node, as disclosed by LeFebvre. *See* Dependent Claim 12, Section IX.F.4 above, which is incorporated here by reference.

**b. Limitation 15(b): “b. communicating said alarm condition to an off-railcar location.”**

270. Armitage discloses wirelessly reporting alarm conditions to a “collection system” that is located off the train. *See* Dependent Claim 6, Section IX.E.4 above, which is incorporated here by reference.

271. In my opinion, a PHOSITA could have arrived at the solution of claim 15 by combining prior art elements according to known methods to yield

predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of Armitage, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 15.

## **8. Dependent Claim 16**

**a. Limitation 16(a): “The method of claim 14 further comprising the steps of: a. making a determination of an alarm condition based on data received from two or more of said sensing units”**

272. Armitage’s control node aggregates data from multiple sensor nodes located on the same train, and uses heuristics to analyze the aggregated data and determine if an alarm should be raised. *See* Limitation 1(a) and Limitation 1(b), Sections IX.E.1.b and IX.E.1.c above, both of which are incorporated here by reference.

**b. Limitation 16(b): “b. communicating said alarm condition to an off-railcar location.”**

273. Armitage’s control node wirelessly reports alarm conditions to a “collection system” that is located off the train. *See* Dependent Claim 6, Section IX.E.4 above, which is incorporated here by reference.

**9. Dependent Claim 17: “The method of claim 14 further comprising the step of placing said one or more sensing units in a stand-by state when said**

**one or more sensing units is not reading data from any of said sensors or transmitting data.”**

274.        *See* Limitation 14(a), Section IX.F.6.b above. For the same reasons I have discussed above with respect to Limitation 14(a), it is also my opinion that each limitation of Dependent Claim 17 is obvious in view of Armitage.

Specifically, the opinions I have expressed in paragraphs 262–264 above<sup>252</sup> above also reflect my opinions with respect to Dependent Claim 17, and are incorporated here by reference.

**10.    Dependent Claim 18: “The method of claim 14 further comprising the step of joining a mesh network consisting of one or more sensing units located on said railcar.”**

275.        *See* Dependent Claim 3, Section IX.F.2 above. For the same reasons I have discussed above with respect to Dependent Claim 3, it is also my opinion that each limitation of Dependent Claim 18 is obvious in view of Armitage.

Specifically, the opinions I have expressed in paragraphs 250–252 above also reflect my opinions with respect to Dependent Claim 18, and are incorporated here by reference.

## **11.    Dependent Claim 20**

**a.    Limitation 20(a): “The system of claim 14 further comprising the steps of: a. saving data received from said one or more sensing units in memory”**

276.        Armitage discloses that each control node contains “memory devices” and “computer readable storage mediums.” Armitage, ¶¶ [0016], [0035]. *See also* Armitage, ¶ [0049] (describing storage system 521 as a component of control node

500). Additionally, a PHOSITA would understand that data received from the sensor units is stored in some form of memory (e.g., in RAM or on a hard drive) on the control node until it is processed.

277. For example, as I will explain in detail below in Limitation 20(b), Armitage discloses heuristics that involve comparing currently collected data against *data collected during a previous time period*, which would necessarily be stored in memory on the data control unit.

**b. Limitation 20(b): “b. comparing data received with said saved data to identify trends or deviations from normal readings of said data stored in memory.”**

278. Armitage discloses heuristics that involve comparing currently collected data against stored data collected during a previous time period.

279. For example, Armitage teaches that a “standard deviation metric” can be used to determine when data from one or more sensor nodes becomes an outlier. EX1006, ¶ [0041]. Calculating the standard deviation involves comparing the current data point (received from the sensor unit) against the mean value of previously collected data points (which are stored in memory on the control unit).

280. Similarly, to apply the “trend modeling” heuristic disclosed by Armitage (EX1006, ¶ [0044]), current data is compared with data collected during an earlier time period in order to generate a trendline.

281. In my opinion, a PHOSITA could have arrived at the solution of claim 20 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of Armitage, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 20.

## **12. Independent Claim 21**

### **a. Claim 21 Preamble: “A method for monitoring the operation of a railcar comprising:”**

282. See the Claim 1 Preamble, Section IX.E.1.a above. For the same reasons I have discussed above with respect to the Claim 1 Preamble, it is my opinion that the Claim 21 Preamble is also obvious in view of Armitage. Specifically, the opinions I have expressed in paragraphs 188–190 above also reflect my opinions with respect to the Claim 21 Preamble, and are incorporated here by reference.

### **b. Limitation 21(a): “a. collecting data at periodic intervals about one or more operating parameters of said railcar using one or more sensor units provided on said railcar”**

283. See Limitation 14(a), Section IX.F.6.b above, which is incorporated here by reference.

**c. Limitation 21(b): “b. communicating said collected data to a communication management unit”**

284. See Limitation 14(a), Section IX.F.6.b above, which is incorporated here by reference. A PHOSITA would understand that Armitage’s control node is a “communication management unit” in the parlance of the ’673 Patent.

**d. Limitation 21(c): “c. analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data.”**

285. See Limitation 14(b), Section IX.F.6.c above, which is incorporated here by reference.

**e. Claim 21 is Obvious in view of Armitage and LeFebvre**

286. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of independent claim 21. As I have explained in detail above, a PHOSITA could have arrived at the solution of independent claim 21 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of Armitage, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that claim 21 is obvious over Armitage in view of LeFebvre.

### **13. Dependent Claim 22**

**a. Limitation 22(a): “The method of claim 21 further comprising the steps of: assessing the collected data to determine if an alarm condition exists”**

287. *See* Limitation 16(a), Section IX.F.8.a above, which is incorporated here by reference.

**b. Limitation 22(b): “wirelessly communicating said alarm condition to an off railcar location.”**

288. *See* Limitation 16(b), Section IX.F.8.b above, which is incorporated here by reference.

289. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 22.

**X. CONCLUSION**

290. For these reasons, it is my opinion that claims 1–18 and 20–22 of the '673 patent are unpatentable.

\* \* \*

I understand that this declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also understand that I may be subject to cross-examination concerning this declaration, and I will appear for cross-examination, if required of me, during the time allotted for cross-examination.

I hereby declare that all of the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

January 31, 2023

  
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STEVEN RICCA